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Petroleum Engineer

The Engineering Magazine of the Oil and Gas Industry

Volume 1 DECEMBER, 1929 Number 3

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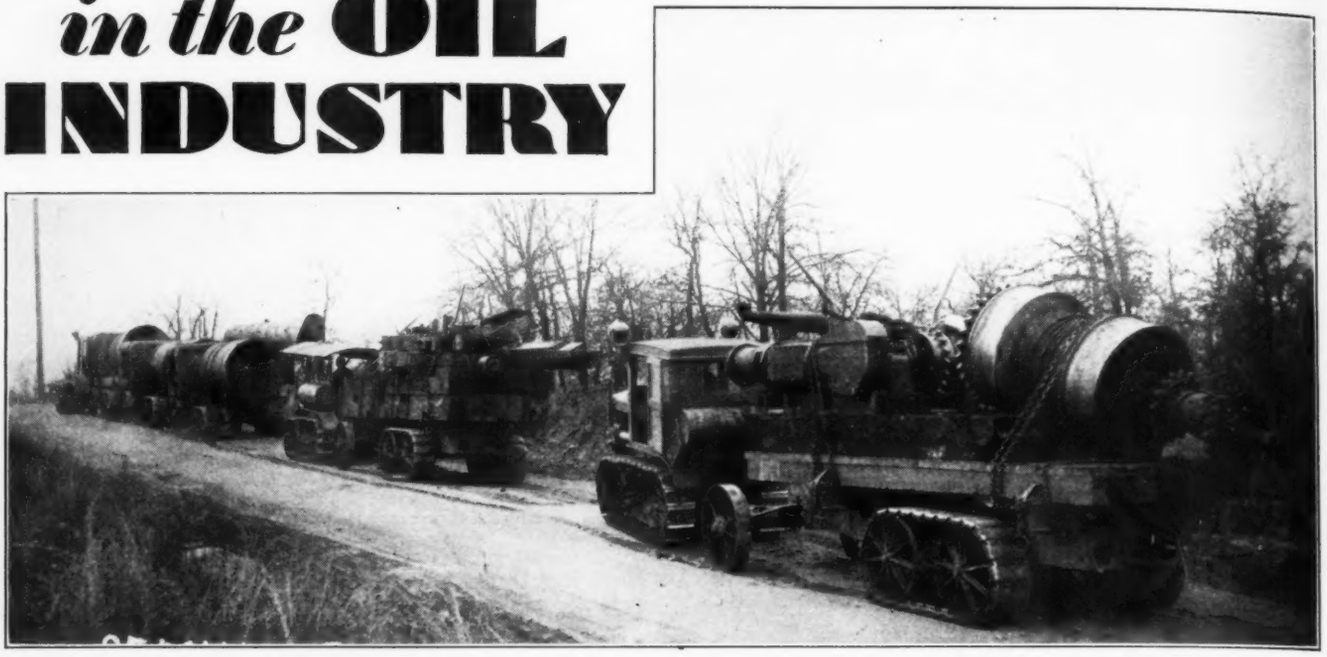

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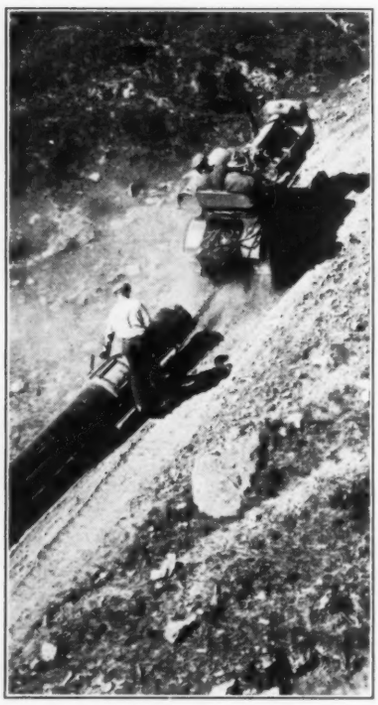

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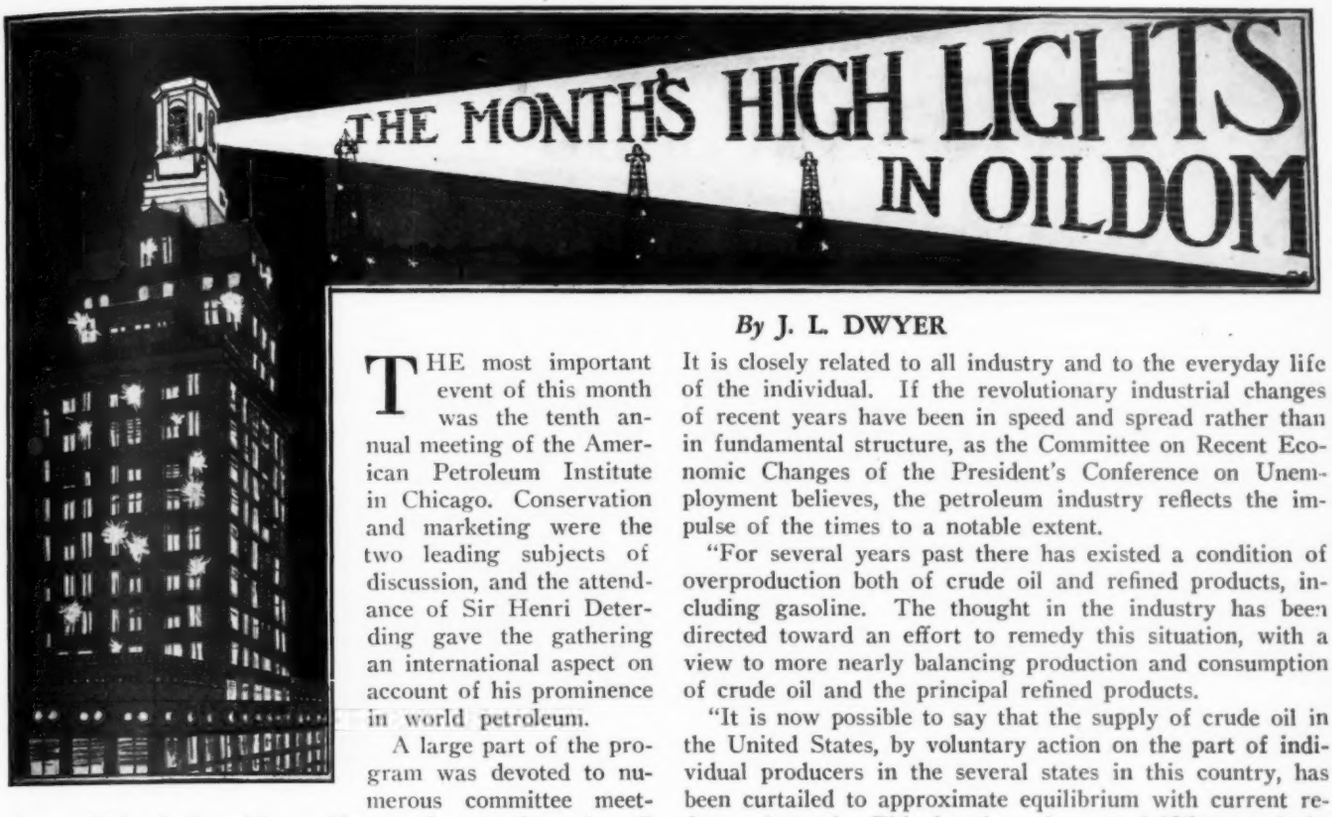


By J. L. DWYER

THE most important event of this month was the tenth annual meeting of the American Petroleum Institute in Chicago. Conservation and marketing were the two leading subjects of discussion, and the attendance of Sir Henri Deterding gave the gathering an international aspect on account of his prominence in world petroleum.

A large part of the program was devoted to numerous committee meetings which dealt with problems of operations in all departments of the industry. Refinery technology, production practice and corrosion of equipment were treated by various committees charged with investigations along these lines. Most gratifying is the increasing number of field officials and department heads who are now seen each year, in contrast to former times, when the attendance was made up largely of executives.

A. P. I. Sends Representative to Washington

A matter of importance to the industry was the action of the board of directors in sending Capt. J. F. Lucey to Washington in response to an invitation of President Hoover, who asked leading business men to attend a conference for the purpose of analyzing the national business situation. Captain Lucey delivered a message from the board, part of which follows:

"The petroleum industry is strikingly important in its relation to the economic life and social welfare. It occupies, by force of the essential nature of its products, a position of outstanding significance to general prosperity. It is closely related to all industry and to the everyday life of the individual. If the revolutionary industrial changes of recent years have been in speed and spread rather than in fundamental structure, as the Committee on Recent Economic Changes of the President's Conference on Unemployment believes, the petroleum industry reflects the impulse of the times to a notable extent.

"For several years past there has existed a condition of overproduction both of crude oil and refined products, including gasoline. The thought in the industry has been directed toward an effort to remedy this situation, with a view to more nearly balancing production and consumption of crude oil and the principal refined products.

"It is now possible to say that the supply of crude oil in the United States, by voluntary action on the part of individual producers in the several states in this country, has been curtailed to approximate equilibrium with current refinery demand. This has been in part fulfillment of the expressed recommendation of the Federal Oil Conservation Board that the industry itself take steps to conserve the petroleum supply."

Production Is Much Lower

From a production standpoint, much progress was made last month. The daily output of California was reduced by 200,000 barrels, and production and consumption were actually brought into balance. This presages a favorable condition for winter months, and, if the present status be maintained, the industry should enter the new year in a healthy state. The Oklahoma City pool continues to increase in importance. Proration now in effect in the field holds the output around 65,000 barrels daily, and it is considered capable of making about 165,000 barrels.

May Build More Gas Lines

The natural gas situation continues to indicate an expansion program. During the past month negotiations were started which looked toward the construction of a line transporting gas to the city of Omaha.

Production and Refining Figures Furnished by the American Petroleum Institute

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending November 23, 1929

(Barrels of 42 Gallons)

DISTRICT	Per Cent Potential Capacity Reporting	Crude Runs to Stills	Per Cent Operated of Total Capacity Reporting	Gasoline Stocks	Gas and Fuel Oil Stocks
East Coast	100.0	3,495,000	82.4	4,605,000	8,760,000
Appalachian	86.0	573,100	74.3	876,000	782,000
Ind., Ill., Ky.	98.3	2,148,500	86.7	4,252,000	3,915,000
Okla., Kan., Mo.	89.0	2,007,500	69.7	2,634,000	3,943,000
Texas	91.1	3,906,800	78.9	5,627,000	14,645,000
Louisiana - Arkansas	97.1	1,331,800	65.1	1,719,000	5,228,000
Rocky Mountain	93.4	426,700	43.9	1,803,000	992,000
California	99.3	4,654,100	74.6	14,289,000	109,171,000
Total Wk. Nov. 23	95.4	18,543,500	75.5	35,805,000	147,436,000
Total Wk. Nov. 16	94.9	18,591,200	76.1	35,298,000	147,096,000
Texas Gulf Coast	100.0	3,080,700	83.6	4,724,000	11,255,000
Louisiana Gulf Cst.	100.0	929,600	74.8	1,506,000	4,292,000

Daily Average Production

(Figures in Barrels)

	1929 Nov. 23	1929 Oct. 26	1928 Nov. 24
Oklahoma	643,050	680,650	712,950
Kansas	110,650	110,700	96,300
Panhandle Texas	102,600	104,600	64,200
North Texas	89,300	91,900	89,400
West Central Texas	56,850	58,000	54,850
West Texas	357,250	363,400	329,600
East Central Texas	17,350	18,000	21,150
Southwest Texas	74,650	74,850	27,750
North Louisiana	36,450	38,200	38,200
Arkansas	63,950	63,950	83,050
Coastal Texas	148,350	147,300	113,400
Coastal Louisiana	23,300	23,700	21,150
Eastern (not including Michigan)	118,900	119,800	104,700
Michigan	15,000	18,100	2,800
Wyoming	52,500	53,350	58,100
Montana	10,500	10,950	11,550
Colorado	5,100	5,350	7,100
New Mexico	8,000	6,400	2,950
California	699,500	880,500	665,800
Total	2,633,250	2,869,700	2,505,000

Novel Mechanical Features

By
J. H. DAMERON

NEAR the fringe of the timber line in East Texas, designers and builders of gas line compressor stations have beaten a path, so to speak, to the Magnolia Gas Co.'s Latex station, which in itself is a tribute to the design and operation of the plant. While Latex is not the largest of its kind, it gets its prestige because the layout differs in many respects from other stations.

Latex is the key station for the transporting company's two large diameter, telescopic lines coming out of the northeastern and northwestern Louisiana gas fields. One line terminates at Beaumont, Texas, and the other at Fort Worth. It is an 8,000 horse power plant with a capacity of 130,000,000 feet of gas daily. From this somewhat remote point all of the administration work is carried on except the auditing department and the offices of the president, which are located in Dallas.

The station site is on a gently sloping hill which has a sandy surface soil that is difficult to improve. When construction of the station was started, late in 1925, its designers not only had in mind plans for a model station, but one which would prove attractive to employees. This gave the employees a greater pride in their station, keener interest in their work, and attracted a high type of employee which in turn reduced personnel turnovers and maintenance.

Around 250 persons are employed at Latex, and slightly more than half of that number make their homes there. Since the plant was placed in service, there have been few changes in the original group that inhabited Latex. The quarters consist of thirty cottages, two apartment houses and a hotel.

An architect was engaged to design and supervise the construction of the living quarters and the two-story frame administration building. Each cottage presents a different elevation and floor plan, and instead of building them all in a row, the architect took advantage of the topography of the site and built most of them in a semi-circle around the hill.

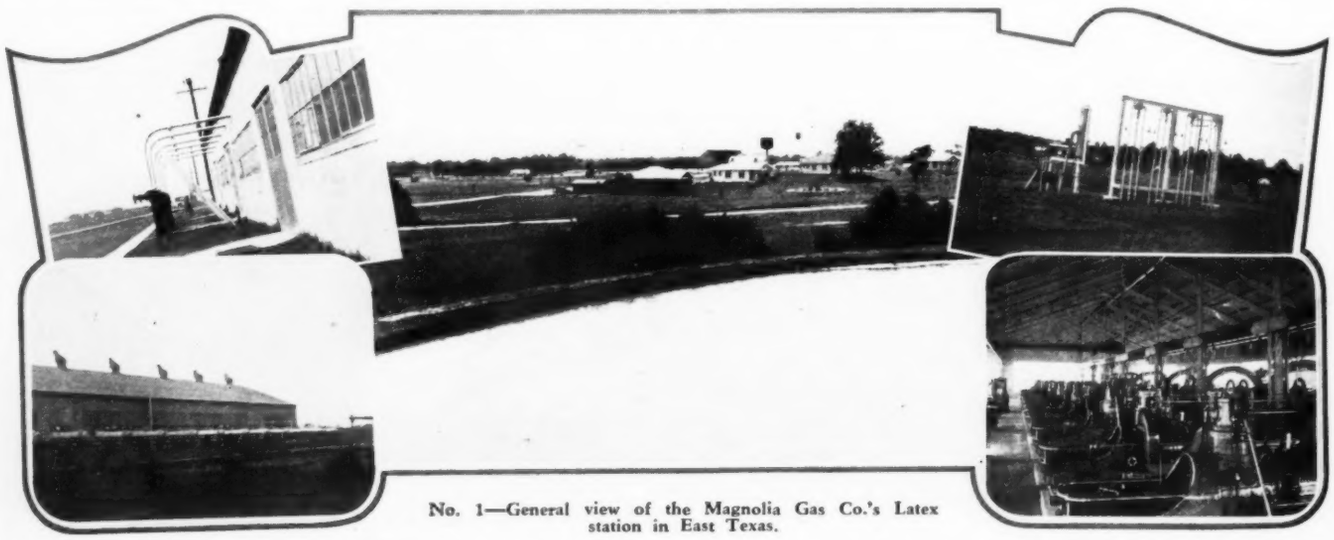
When the cottages were being built, the ladies who were to live in them were permitted to select their own wallpaper and make suggestions for other things they desired in the home, such as painting and built-in features. None of the houses are permitted to get in a neglected condition. At regular intervals, the architect makes inspections and all of the repair and maintenance work is done under his supervision. Most of the landscaping was done around the living quarters where soil conditions were better. Around the station building, warehouse and shops, the soil is in a bad condition, and because of the excessive rains it is difficult to improve.

The key men at Latex and their families occupy the larger cottages. Single men and guests occupy the hotel in which the dining hall is located. Single women living at Latex occupy the top apartments in the apartment houses, and married couples live below. Some of the employees live at Shreveport, which is a 45-minute drive.

Instead of maintaining a commissary, the company operates a truck daily between Latex and Shreveport. The wants of the housewives and chefs at the dining hall are given to the driver daily, and in the afternoon he makes the deliveries.

The water supply at the station is not ideal for domestic use but this is corrected by a modern treating plant. Each building is fitted for gas, water and sewerage and wired for D. C. lighting, which, incidentally, is the reason for a great many battery radio sets at Latex. To add to the beauty and completeness of the station, two lakes were built. One is for bathing purposes, and the other for a water storage supply.

Particular attention is given to the selection of a new employee as a guard against getting one likely to create dissension among other station inhabitants who have proven



No. 1—General view of the Magnolia Gas Co.'s Latex station in East Texas.

Upper left—Tube turns at Magnolia's station in northeastern Louisiana.

Lower left—Aftercoolers set up for 500-pound working pressure.

Upper Right—Valve stand for remote control of gate valve. The handles on chains are painted red and green, making it easy to determine which of the valve control chains to pull and close the gate valves in case of a fire in the station. Directly behind the valve stand is the hook-up for flowing the shallow water wells with gas. The gas, after flowing the well, is turned into the fuel line for the engines.

Lower right—Interior of the "straight eight" 8000-horse power, 130,000,000-foot capacity station. Center columns and two craneways are used, doing away with much truss work in the top of the building.

in Magnolia's Latex Station

congenial. General supervision over the grounds and cottages comes under the direction of M. A. Abernathy, superintendent of gas measurement.

The "straight eight" station is powered by eight 21½x36 twin tandem Cooper 1,000 horse-power engines. Six units are required for normal operation, but rather than run a unit at a fast speed it is the practice to operate two engines slowly, affording less wear and strain on the equipment. Engines are set for a speed of 125 r.p.m., but usually are operated at a speed of 110 r.p.m. Each engine is equipped with two igniting circuits, and each has its individual oil filter and all are connected to a centrifuge. It is the practice to run every engine at least a few hours each day except when down for an appreciable period for repairs or replacements.

The station at Latex is a typical example of the pride in neatness that A. L. Bradford, superintendent of power, takes in all of the compressor stations. Each engine has the appearance of being freshly out of the paint shop. All of the brass work is kept highly polished. Likewise, the floors and walls are in a tidy condition and the subsurface part of the station is also kept neat. Catchalls for rags, trash, etc., are conspicuous by their absence.

One relatively small instrument board suffices for the station, and the floor space has the minimum of tool boxes, etc.

Each member of the operating crew on duty has assigned work in caring for the equipment. When a unit is shut down and another started up, the crew goes over the engine, cleaning it and checking it. If minor repairs are necessary, they are made. In that way each unit is always ready for service, except when it is down for overhauling.

The station building, all steel in construction and bolted to a concrete foundation, and 64 feet wide, is designed for ample lighting and ventilation and to permit the building of additional space whenever more compressors are needed. Considerable truss work in the top of the building is eliminated by the interior design using center steel columns and two craneways. Two of the tracks for craneways are built to the center posts and the other two to the side walls.

Remote Control Valves Used

Outstanding of the several operating features of the station is the flowing of the shallow water wells with gas. Gas coming into the station's main lines is taken out through a small diameter pipe and arrives at the well at 150 pounds pressure. Gas is put in the well at 42 pounds pressure and comes out of the Y fitting going into the separator where the water swirls around and goes to the storage tank, while the gas goes on to the fuel lines for the engines. In this manner, the cost of pumping water is reduced to a minimum.

Of the many safety features, the remote control for the gate valves is probably the most interesting. In the event of an emergency, anyone can go to the valve stand outside the station building and close both ends of the main lines by pulling the proper chains operating the valves. The stand is conveniently located, and probably rightly, in the direction of some near-by timber and on the route the crew would probably take in the event of a fire in the station.

These valves are operated by 200 pounds pressure kept constant at all times. The accumulators are kept full of oil which keeps the oil in contact with the pistons preventing sticking or freezing. When the remote control valves are to be operated all that is necessary is for some member of the crew to seize the chains on the valve stand and pull, releasing the air pressure which in turn operates the pistons closing the valves. The handles on the chain are painted red and green to minimize the possibility of delay caused by pulling the wrong chain.

The station is equipped with extinguishers for fires in the power generating house and hand extinguishers for smaller fires. The several other safety devices consists of guards around moving parts, elimination of stumbling and tripping hazards and warnings.

The natural gasoline plant operated in connection with

An air view of Latex from the Gasoline Plant, showing the manifolds and rising stem valves, and the remote controlled gate valves.

Upper left—Warehouse at Latex—note the hand-operated crane on the end of dock for lifting valves and other heavy equipment.

Lower left—Detail view of one of the remote controlled gate valves operated by 200 pounds air pressure.

Upper right—General view of Latex station, showing gasoline plant, water towers, cooling tower and station.

Lower right—Side view of Latex station.

the compressor station reflects the same care in design that was placed in the compressor station and grounds. One of its many features is that all control valves are located outside of the plant. Its equipment is likewise kept in excellent condition.

All of the company's construction work and maintenance of pipe lines is carried on from Latex under the direction of W. Mike Murphy, superintendent of gas lines. District foremen for the immediate territory around Latex are headquartered at the station with their crews and can be dispatched to a break within a short time after it is discovered. All of the transporting company's lines are welded and the welders at the Latex shops build all of the shop fittings required for construction. Incidentally Latex is an experimental laboratory in a measure for new line pipe.

The warehouse at Latex, under the direction of D. E. West, superintendent of stores and supplies and headquartered in Dallas, is stocked with an ample supply of parts and fittings. The warehouse at all times is in an orderly condition with a place for every item stocked and that item in its place. In addition to carrying emergency parts for the compressors of the several stations on the line a complete stock of pipe, valves, fittings, paints and other equipment is carried. One of the several refinements found at the warehouse is the hand-operated crane on the dock for loading heavy parts on trucks.

All the tools for construction and repair work are kept in the warehouse and in places where they can be readily found after being returned from a job. Because part of the gas line runs parallel to an oil line of an affiliated company numerous supplies for the oil line are stocked.

By mathematical calculations on a chart prepared for the purpose engineers can determine approximately where a break is when one is discovered. By having this knowledge the crews going out to make the repair can get from the warehouse the supplies they will probably need to make repairs on that section of the line and thereby save time. In the swamp country that frequently is an item of importance.

The shops and garage are located a short distance away from the warehouse. At the former all of the company welding is done as well as being used for the building of equipment or parts. When the full time welders are not engaged in necessary work their time is devoted to making odds and ends for the stations.

The chief dispatcher's office, under the direction of E. M. Smith, and walled in with an array of gauges, telegraph and telephone equipment, is located in the administration building. In this, "the eyes of the system," are most of the instruments ordinarily found in the station. And with these instruments and weather reports, the chief dispatcher knows a few hours beforehand what kind of a load will be put on the line in distant cities.

By having virtually all of the administration work centralized at Latex, a modern plant, and with somewhat unusual methods of selecting and caring for the personnel, the tranporting company has a smooth running system showing a satisfactory operating cost and a satisfied personnel with all the results expected of such a condition.

J. I. Irvin, chief engineer.

M. A. Abernathy, supt. gas measurement.

A. T. Sinclair, chief engineer.

A. L. Bradford, supt. of power.

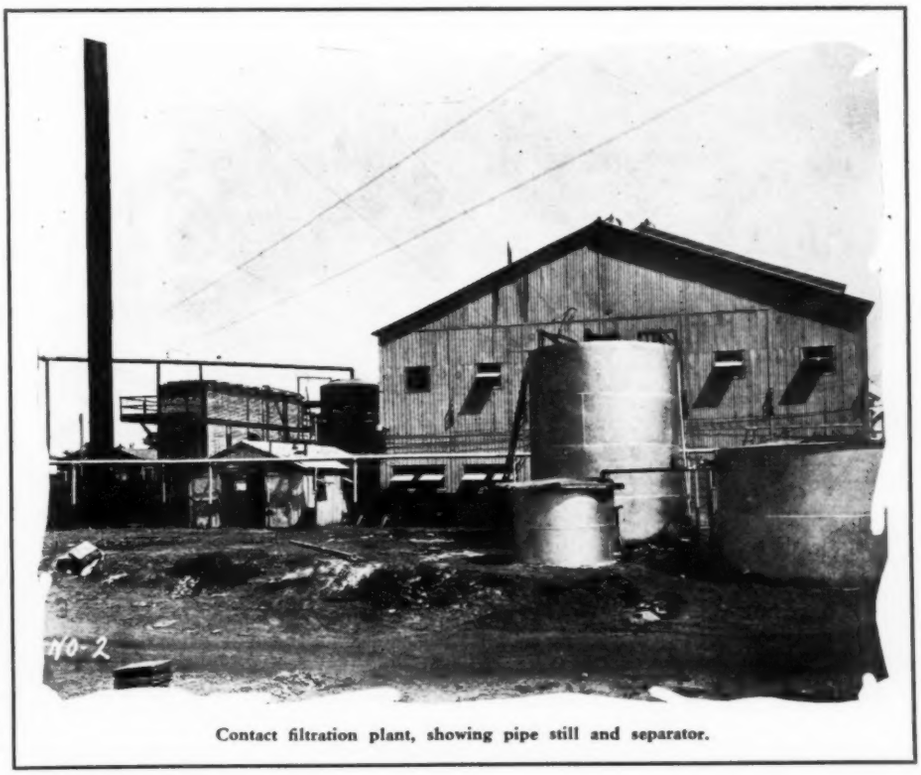
Many refiners using fine clays to

Process Oils by Contact Filtration

By F. R. STALEY

THE use of fine clays, either in the raw or acid state, is being more widely adopted by the refiner as a means of treating both lubricating and light oils. The process has a distinct advantage in the manufacture of lubricants from mixed and naphthene base crudes, since the clay will neutralize and decolorize the acid treated stock simultaneously which eliminates the use of soda neutralization. The process is also used by some refiners on Pennsylvania grade crude on which no acid is used.

Considerable literature has been written on the theory and practice of contact filtration, and much research work is in progress to locate clay deposits of high decolorizing efficiency, and to revivify the spent filter cake. It has been demonstrated that the spent clay can be best recovered by burning in a multiple hearth furnace at a temperature of approximately 900° F. The efficiency of the recovered clay being about 85 to 90 per cent as high as the fresh clay. When the oil has been filtered in a naphtha solution the spent clay cake may contain from 25 to 30 per cent of naphtha. It is necessary that this is reduced to a minimum (not over 5%) in order to control the temperature of burning. The naphtha recovery, or elimination, involves special problems. Some refiners use steam in the filter press. In this case canvas leaves are used and must be frequently replaced, however, the value of the naphtha recovered makes the method economical. When metallic cloth leaves are used, the use of steam will plug the cloth in a short time, and it is necessary to use a residue gas to blow the cake. Another method of reducing the naphtha is to feed the cake to a kiln and distill off the naphtha in an atmosphere of superheated steam before burning it in a multiple hearth furnace.



Contact filtration plant, showing pipe still and separator.

Clays

A wide variety of clays are used for contact filtration. California, Texas, and Utah deposits are the most noted. Considerable variation in decolorizing efficiency is obtained with various clays on a given oil. In the case of acid treated clays the quantity of acid and its concentration are important. When raw or untreated clay is used it is ground so that not less than 90 per cent will pass through a 200 mesh screen. For acid treated clays it is important that the grinding is more closely controlled. The ground clay must not contain a high percentage of very fine particles since this would involve loss of material and efficiency when washing the pulp after the acid treatment. In grinding clay for the pulp process it has been found that the most suitable particle size is through the 100 mesh and on the 200 mesh screen; however, in actual practice the grinder is usually run so that 85 per cent will pass through a 200 screen. Acid treated clays are applied to the oil either dry or in the form of pulp, containing 20 to 30 per cent of solids. The latter method is used by those refiners having clay treating plants. In this case the raw clay is received at the refinery, ground to mesh, cooked with acid, washed, and the clay pulp used on the oil. The process usually involves a loss of 20 to 30 per cent, most of it being the cooking and washing loss. The clay is converted into hydrosilicates and aluminum sulphate. The latter is washed out of the pulp.

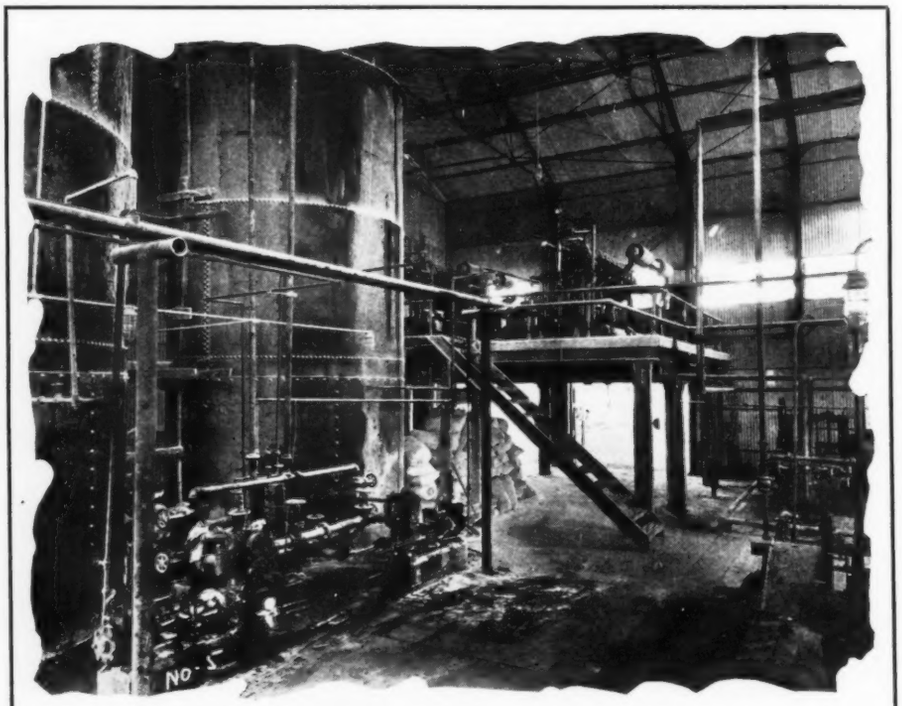
Some refiners purchase acid treated clay in the dry form, containing from 5 to 10 per cent moisture. This eliminates the investment in a clay treating plant, and eliminates the transportation of 10 to 20 per cent inert content which has no efficiency in treating oils.

Whether the clay is used either in the dry or in the pulp form it is added to the neutral or acid oil in a small tank and mixed by means of a stirrer or circulated with a pump. A predetermined amount of clay is added which will depend upon the efficiency of the clay, color desired, and the acidity of the oil. A bright stock or long residium will require from 8 to 30 pounds of clay per barrel. When it is necessary to acid treat an oil before contacting, it is usually more economical to make as much color as possible with the acid and thus reduce the quantity of clay necessary to a minimum. On certain treated oils, as overhead bright stocks, only enough clay is used to neutralize and stabilize the color, since

the color of the oil is so good that it does not require filtering.

In acid treating an oil for contact filtering, it is very important to eliminate all fine sludge held in suspension since its presence increases the quantity of clay required and makes revivification more difficult by increasing the sulphate content of the cake. Some refiners run the acid oil through centrifuges before contacting, but this is not necessary if the sludge is properly gathered by using a small amount of water or by settling the sludge at the proper temperature.

After the oil and clay are mixed, it is circulated through a pipe still or heater at high velocity. In the pulp process the moisture is flashed off as steam. Usually steam is injected into the still to improve the results and prevent any danger of cracking the oil.



Interior of contact filtration plant manufacturing bright stocks.

The temperature of contacting is important. It will depend upon the flash and viscosity of the oil being treated and upon the clay used. For pale overhead oils the temperature will vary from 300 to 400° F., and for long residium or bright stocks from 400 to 500° F. The effect of the temperature is to reduce the viscosity of the oil and effect more intimate contact with the clay. At this point, it is important to note that too high a temperature will crack the waxes so that difficulty in dewaxing might result. After the oil clay mixture is brought up to the required temperature it is usually pumped off continuously through a cooler to the filter press, in the case of hot filtration, or it is pumped to a mixing tank at a lower temperature to be blended with naphtha in order to reduce the viscosity for filtering.

The clay can be filtered from the oil hot (300 to 350° F.) or in naphtha solution at atmospheric or (100 to 150° F.). In the case of neutrals or pale oils, hot filtration is usually used while long residium or bright stock is filtered in naphtha solution, containing about 50% of naphtha. Considerable attention must be given to the filtering operation in order to properly build a cake on the leaves so that no very fine clay particles are carried through the cloth.

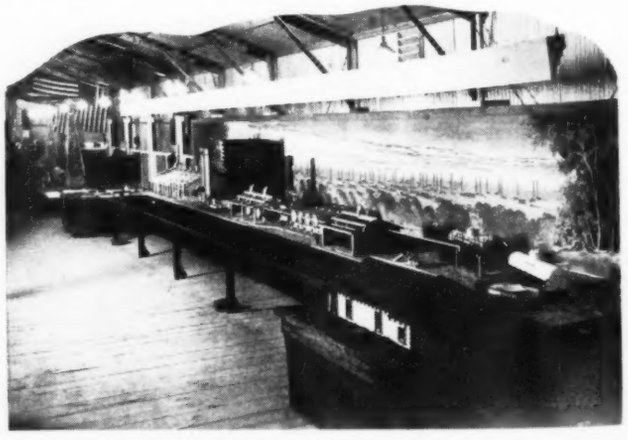
If the clay is ground too fine or if the sludge is not properly removed from the oil after acid treatment, there is a possibility of the finished oil having a poor emulsion test. Some refiners strain the oil through a shallow bed of clay in a percolator to improve this test, but this is unnecessary if the process is properly controlled.

When a naphtha solution is filtered, the cake is washed with naphtha and then blown with air, gas, or steam to recover the naphtha. In the case of hot filtration the cake is dropped and mixed with naphtha of heavy distillate to recover the oil from the cake. The lubricating oil is recovered from the solution by distillation. The profitable operation of the process is often determined by the cake losses. By the proper acid treatment, and the use of a highly efficient clay, the quantity of clay required can be reduced to a minimum which means a small cake loss. Successful methods of reburning fine clays in multiple hearth furnaces are now in use by some refiners which materially reduces the cost of contact filtering.

In order to determine the efficiency of a clay on a certain oil to be contact filtered, it is best done by actually trying it out in the laboratory as the chemical analyses of two clays are no bases for comparison, and a clay that would give excellent results on one kind of oil would prove unsatisfactory on another. It is also necessary to acid treat some clays before trying to determine their efficiency, as no results would be obtained in the raw state.

The efficiency of a clay for filtering can be readily determined in the laboratory by mixing a certain percentage of the dry clay or pulp to the neutral or acid treated oil (sludge free), and heating in a beaker with constant stirring to the flash point of the oil, passing through the mixture a steady current of steam. The clay is then filtered out and the color and other tests of the oil made.

Some refiners use finely ground raw, or specially refined clay to stabilize the color or reduce the gum content of gasoline or kerosene. The clay is added to the oil and circulated by means of a pump, allowed to settle, and the last traces washed out with water. Another method is to filter the clay out in a filter press. The use of clay in refining gasoline, instead of sulphuric acid, presents special advantages in refining anti-knock gasoline from cracked distillates.



Miniature working model of a refinery and gasoline plant displayed at the International Petroleum Exposition.

Many Difficulties Attend the

Treating *of* Cut Oil *in* Cold Weather

AS the mercury in the thermometer starts sliding downward the oil treater's temperature starts rising with his temper because of the additional troubles he usually encounters in treating cut oil during the winter months. Some of his troubles, it is pointed out, can be reduced with closer control of his treating plant.

Most troubles in treating during the winter months originate in the holding of proper temperature of the cut oil and the treating solution. Chilling of cut oil during the winter precipitates the heavier constituents and waxes in the oil. These combine with b. s. and give an apparently higher b. s. content to the oil in winter than in summer. With the temperature of the treating solution lower its viscosity is increased and it does not flow as rapidly. Checking the flow of solution into the flow line by watching it through the sight feed is often misleading. It may appear to be flowing as normally as in the summer months because the stream is as large, but because of the higher viscosity the stream is traveling more slowly.

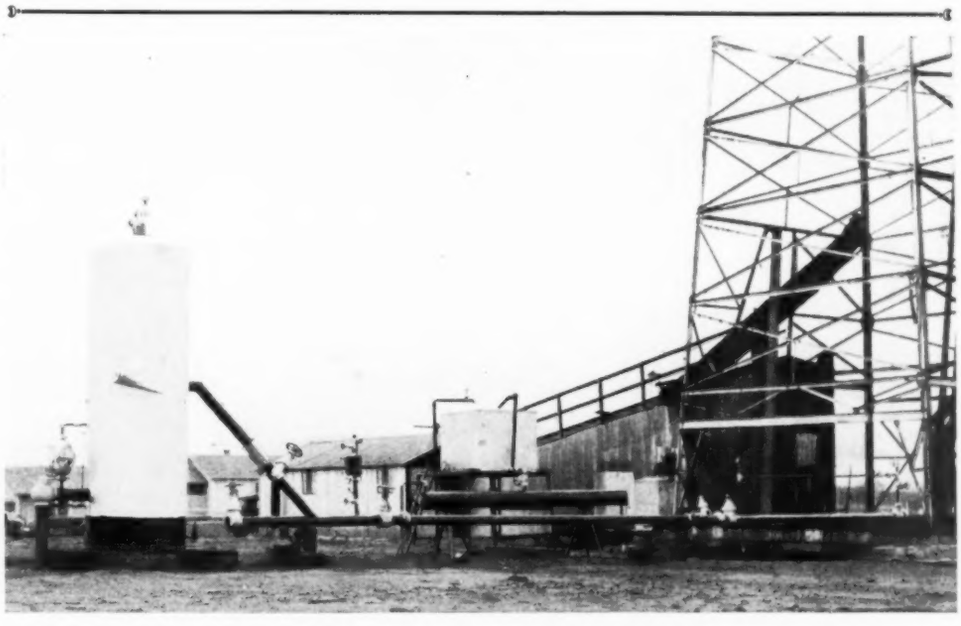
The Shell Pet. Corp.'s oil treating plant in Winkler County, Texas.

To overcome this condition some operators have taken steps to protect the solution mixing tank from the elements in order to maintain a more uniform temperature. The most common practice during cold weather is to use more chemical to offset the loss of temperature. This practice is more costly and not as effective as holding the solution at a higher temperature. Many of the most efficient operating plants introduce the solution as close to the well as possible to get the benefit of maximum agitation, and after that the oil is run to a tank, where it will remain quiet and free from agitation while treating out.

In the Nowata area of Oklahoma there are several inexpensive and economically operated plants for leases with small production and wells with little gas. Essentially the layout calls for a lubricator, heater, separator and gas-tight tank. Aside from the tank and separator it is estimated that the layout will have a limited cost because much of the equipment can be made from otherwise junk material.

The lines from the several wells are manifolded and the treating solution introduced into the line going to the tank with a lubricator or, preferably, a pump. The oil with the solution flows to the gas trap made of a 20-foot joint of 15-inch pipe. This line enters the trap about six feet from the bottom, and the fluid flows out of the trap from a connection placed a short distance above the top of the treating tank.

The oil flows down to the bottom of the tank through a 12-inch conductor and meets the hot water flowing into the tank at the water line. The conductor serves two purposes. Its chief advantage is flowing the cut oil up from the bottom through the hot water instead of down from the top through the cleaner oil. Its other feature is that the cut oil flows directly in contact with the hot water. The tank has two connections to the stock tank, one near the top and the other near the center. If the oil is difficult to treat, then it can be held in the treating tank all night.



A typical hook-up for treating emulsified oil in the Seminole field. The lubricator on the flow line near the separator is used quite frequently during the cold months. The larger lubricator is used to send the solution to the bottom of the hole on wells being produced with air lift.

The heater, like the trap, is made from salvaged pipe with a low pressure gas burner in one end and a 4-inch stack, with a damper, in the other. The hot water flows through a pipe going through the tank and into the 12-inch conductor. It is returned to the heater with a water line in the bottom of the tank. Both water lines are equipped with check valves.

Completion and Control of High Pressure Wells

By K. C. SCLATER

WHEN the drill pipe is pulled, there is a reduction of the mud-fluid level in the well. This reduction is great enough that it constitutes a serious blow-out hazard in the wells as they penetrate the high-pressure zones. The magnitudes of this reduction for different sizes of holes and drill pipe are shown in the following table:

TABLE SHOWING ROCK PRESSURE, STATIC MUD-FLUID PRESSURE AND REDUCTION IN MUD FLUID COLUMN BY REMOVAL OF DRILL PIPE.

DEPTH WELL,	ROCK PRESSURE LB. PER SQ. IN. OKLA. CITY FIELD	STATIC MUD FLUID HEAD LB. PER SQ. IN.	Estimated Mud Fluid Levels When Drill Pipe Is Pulled									
			6⅝-in., 25.2-lb. Drill Pipe						4½-in., 16.6-lb. Drill Pipe			
			15-in. hole		12-in. hole		10.772-in. hole		10.772-in. hole		8-in. hole	
			Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
4000 ft.	1520	2182	3221	3798	2778	3686	2484	3608	3302	3759	2734	3560
5000 ft.	1900	2728	4027	4749	3472	4608	3105	4511	4128	4699	3417	4450
6000 ft.	2280	3273	4832	5699	4166	5529	3726	5413	4953	5638	4101	5340

10.772 is I. D. of 11¾-in. A. P. I. Casing.
Mud Fluid of 10½ lb. per gallon assumed.
Tool Joints 25 to 30 ft. apart.
Rock Pressure 38 lb. per 100 ft., depth based on field observations.

It is the practice therefore, while pulling drill pipe in deep drilling wells, to keep the mud-fluid level high enough to overcome the estimated rock pressure.

Actual readings taken on several wells are shown in the following table:

ACID BOTTLE READINGS TAKEN INSIDE DRILL PIPE IN WELLS IN OKLAHOMA CITY FIELD.

DEPTH	Degrees Deviation From Vertical								
	Well 1	Well 2	Well 3	Well 4	Well 5	Well 6	Well 7	Well 8	Well 9
500 ft.	0	0	4	1½	0	0	2	0	0
1000 ft.	½	0	2	2	2½	2½	5	0	0
1500 ft.	0	2	3	3	2	0	2	0	0
2000 ft.	2	5½	0	2	0	0	½	1½	0
2500 ft.	1½	1½	0	0	2	0	0	2½	0
3000 ft.	2	2	0	1	4	0	0	0	0
3500 ft.	1½	0	2	1½	5½	½	0	1	½
4000 ft.	0	3	1	1	7	0	0	1½	0
4500 ft.	2	2½	1½	2	2	0	0	2½	
5000 ft.	2½								

The horizontal correction of the discovery well at 6420 feet was only seventeen feet, a truly remarkable record.

Extra equipment used on the drill stem to assist in holding the bit to a vertical course consists of a heavy drill pipe joint nine inches in diameter and twenty-four feet long, with a double three-point reamer above it, placed immediately above the bit. Much of the success in keeping the holes straight in the field is ascribed chiefly to holding as much weight off the bit as is consistent with a fair degree of drilling speed.

Positive evidence of the detrimental results of too much haste in drilling in the Oklahoma City field by crowding the bit is found in the case of one well where 1,000 feet of hole was drilled in two 12-hour tours. An acid bottle survey of this 1,000 feet of hole showed a vertical deviation of ten degrees, an amount six to eight degrees greater than normal.

Another factor which aids in drilling holes vertical is the centering of the rotary table in the derrick. This eliminates the tendency of the Kelly to pull over that exists when the rotary table is off center.

The practice of holding the weight up is also believed to have eliminated a lot of drill pipe trouble. Comparatively little drill-pipe trouble has characterized drilling operations in this field. In this connection, it is estimated that a string of heavy special alloy steel drill pipe can safely be used for at least four wells in the Oklahoma City field. Below 3,000 feet, blowout preventers are in use. In the high-pressure zones below 4,000 feet, a blowout preventer is a necessity for keeping proper control of the well.

Running and Cementing Casing

To date, two main producing zones have been developed, one in the "Siliceous lime," the other in what is known as the "Detrital zone." From 250 to over 500 feet from the top of the "Siliceous lime" three or four producing horizons have been penetrated. The upper 250 feet of the "Siliceous lime" is a dense dolomite which is unproductive.

In the earlier wells drilled, the practice was to drill fifty or sixty feet into the "Siliceous lime" with the rotary tools, then suspend the casing about ten feet off bottom and cement at this point. Standard cable tools were then used

A recent view of

Mud Fluids are Big Factors in Deep Drilling. New Work Has Numerous Operating Novelties Responsible for Straighter Holes

***EDITOR'S NOTE—** This article is a continuation of Mr. Sclater's pertinent discussion of high pressure problems, the first section of which appeared in the November issue.*

to drill out the cement plug and "drill-in" to the pay horizon.

Present practice is to complete the well to the finished depth with the rotary tools, suspend the casing 250 to 450 feet off bottom, according to the productive horizons penetrated, and cement behind the casing with the part of the hole below the casing shoe, full of mud fluid. Standard cable tools are used only to drill out the cement in the casing and any cement that has "bridged" below the casing shoe.

Average casing strings and amounts of cement used are as follows:

Size and Weight of Casing	Average Depth to Which Run (Ft.)	Amount Cement Used (Sacks)
15½-in. (Surface String)	250-300	150
9 -in., 45-lb. Seamless	4800-5280	1000
7 -in., 28-lb. Seamless or 6⅝-in., 26-lb. Seamless	6080-6256	250
4¼-in., 16-lb. Seamless	6180-6380	.....

A careful check is made on well depth measurements before running casing. Field engineers are held responsible for checking all measurements and cementing operations. In some of the earlier wells that were drilled in with standard cable tools, it was the procedure to check and make sure casing was on bottom by a mud circulation test, then lift it off bottom about ten feet.

With increasing knowledge of the underground conditions and also the fact that it is now general practice to drill the total depth in the "Siliceous lime" wells with rotary tools, casing is now set and cemented by careful check measurements. Casing is floated in, for which purpose two float collars are used, one on the second, and one on the third joint from bottom. A cement guide shoe is also used on the bottom of casing. All casing is run through a heavy approved type of control head and blow-out preventer. Every precaution is taken to ensure a successful cementing job. Evidence of the effectiveness of the methods used, is the fact that no cementing failures have occurred to date on The Indian Territory Illumination Oil Company wells. The two-plug method is used in placing the cement behind the casing. Instead of a measuring line, the quantity of mud pumped in on top of follow-up plug is measured to ascertain if the cement is in proper position. Gas-cutting of the mud fluid, which increases its volume, is one of the possibilities of error to be guarded against in this method of measurement.

When mud fluid is used to follow up the cement plug, a considerable reduction in pump pressure is obtained when placing the cement behind the casing. Average final pump pressures range from 600 to 900 lb. per sq. in. in cementing long strings of casing. A 6⅝-in. string of casing, set and cemented with 250 sacks of cement at about 6372 feet, took a final pump pressure of about 800 lb. per sq. in.

"Detrital zone" wells usually are drilled to the top of the sand, at which point the casing is hung just off bottom and cemented. In this respect they differ from the "Siliceous lime" wells.

Wells in the field are brought in "Barefoot". No trouble is experienced with caving as the formation stands up well.

In one "Detrital zone" well completed, sand trouble has developed in producing the well, not due to caving, but because of a very fine siliceous silt carried in suspension. Special screen pipe has been tried to overcome the trouble, but to date, it has not proven successful. It is quite probable that "Detrital zone" wells will have to be produced through special screens or liners at the pay horizon.

A uniform method of making up each joint of casing is strictly adhered to. In running 9-in. casing, for instance, four wraps of manila rope are used on the cathead, then about two revolutions with the tongs. Any noticeable variation in the way the joints of casing make up is investigated and reported. Under no consideration, is anything used on the threads other than a specially prepared pipe-thread lubricant furnished. Special alloy steel casing of high collapsing and tensile strength is used. Average time for running 5,200 ft. of 9-in. casing is from nine to ten hours.

As was previously mentioned, it is the field engineer's duty to check all casing measurements and cementing operations. An idea of the thoroughness of this checking and the type of data gathered by the field engineer is had by observing the various items included in the "Casing Report" which the field engineer is required to submit on each casing

the Oklahoma City pool.

and cementing job as soon as completed. A specimen of one such "Casing Report" is presented here.

CASING REPORT

Lease (.....)
Well No. 1. Date Run, August 13, 1929.
Make of Casing (.....) Seamless.
Size Casing, 5⅝" O. D. 26 lb., 10 thread, A. P. I.
Float Collars (.....) (Cement).
Casing Shoe (.....) with guide.
Time of Running Casing, 13½ hours.
Make-up, Uniform.
Joints Discarded, None. Reason Discarded.
Used 250 Sacks (.....) Cement, No Accelerator.
Condition of Cement and Nature of Mix: Cement was in good condition and mix averaged 4½ to 5 gallons of water per sack.
Work by (.....) Oil Well Cementing Company.

CEMENT Job

Date, August 13, 1929.

Mixing and Pumping in 250 Sacks, 1 Wagon	14 Minutes
Starting Plug Down	4 "
Pumping Down Cement	40 "
Total Time	58 Minutes

PUMP PRESSURES

Initial	200 lbs. per sq. in.
Pressure When Cement Was Placed	600 " " " "
Final Pressure	800 " " " "

CASING TALLY

	Ft.	In.
T. D. of Hole 6540 Ft. Corrected by Drill Pipe Tally to Read	6542	6
Casing Tally, Threads Off	6115	7
Top of Casing Below Floor	9	6
Casing Set at	6125	1
Casing off Bottom	417	5

Remarks:

Before running 6⅝" casing, the hole was circulated with 11-lb. mud which had been treated with a preparation. The mud was in excellent condition, being of sufficient weight to avoid gas cut or disturbance of the walls of the hole by gas and also possessing a lubricating quality which is obtained by proper application of suitable materials.

100 ft. of 6⅝" casing was made up before going out of the 9" and stood in the rig. This 100 ft. was pumped down and casing was landed without difficulty.

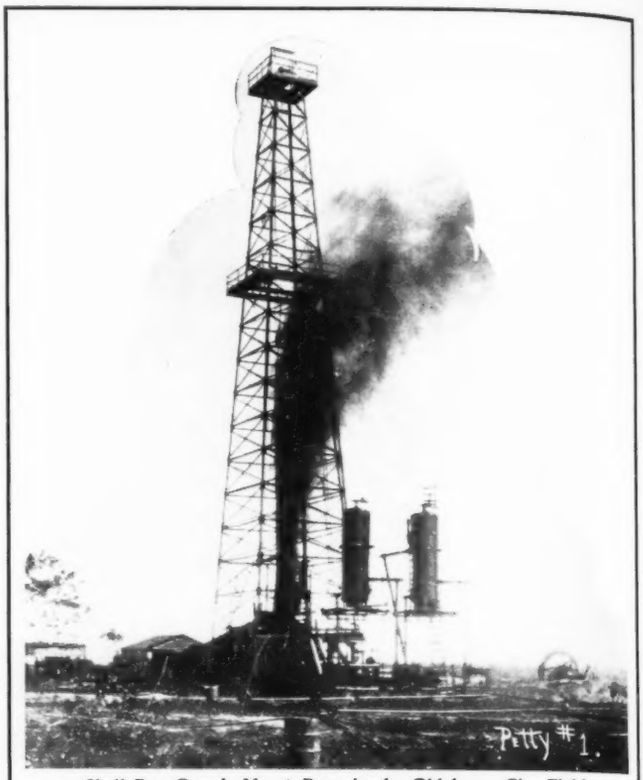
An instance of the value of accurate measurements was witnessed on a well where a 6300-ft. string of 6⅝-in. casing was being run in a "Detrital zone" well. About eight joints off bottom circulation stopped, the mud pumps slowed down and the pressure suddenly increased. All indications at the surface were that the casing was on bottom. Casing and well-depth measurement figures were checked and rechecked but no errors in the original calculations could be found. Finally, after maintaining a high pressure on the mud pumps and working the casing for about nine hours, circulation was re-established. The remaining eight joints were run, although much slower than those already run in the well, and the casing finally set at the previously determined point. What really happened was, the hole had bridged below the casing shoe. Accurate measurements carefully made and recorded gave definite assurance in this case that the casing was not on bottom when circulation stopped.

Control in "Bringing In" Wells

Cement is allowed to set about seven days before drilling out. Casing head connections in drilling-in usually consist of two high-pressure drilling gates, control head or blow-out preventer, and Christman tree connections. Lead lines, equipped with flow beans, to one or more separators, depending on the size of the well, are all connected up in readiness before the tools are run. After the cement is drilled out in the "Siliceous lime" wells, the tools are pulled out and the well is very carefully bailed down, a little at a time, until the well starts to flow. Immediately the fluid shows any indication of rising in the casing, the bailer is pulled out and the well turned into the separator.

Drilling Time, Water and Gas Fuel Consumption

Since the development of the field began, the completion time on wells has been reduced from about 195 days to 135 days. Rapidly accumulating knowledge of underground



Shell Pet. Corp.'s No. 1 Petty in the Oklahoma City Field.

conditions and assiduous effort on the part of operators to improve drilling and control methods are wholly responsible for this decrease in drilling time. Referring to chart, Fig. 2. the average drilling time, based on the arithmetical average of depth at five-day intervals, on 25 recent wells was 89 days to 6,500 feet or an average of 73 feet a day. Fastest drilling time in the field to date, was made on the T. B. Slick, Glidden No. 1, and the T. B. Slick, Glidden No. 2. In No. 1, the 9-in. casing was set at 5,293 ft., thirty-seven days after setting surface pipe, and in No. 2, the 9-in. casing was landed at 5,207 ft. after setting surface pipe.

The total average cost of a well, fully equipped and on production, in the Oklahoma City field, is from $140,000.00 to $145,000.00. Add to this another $10,000.00 to $12,000.00 per well for lease equipment and improvements.

Total water consumption per well will average about 140,000 barrels. This is based on an average consumption of 2,500 barrels a day per well above 3,000 ft. and 1,500 barrels a day per well below 3,000 ft. Water thief sands above 3,000 ft. account for the greater consumption at the shallow depth. With some 150 wells drilling, the daily water consumption in the Oklahoma City field reaches astounding figures. To meet its field requirements, The Indian Territory Illuminating Oil Company has installed an elaborate water system which has a normal capacity of about 150,000 barrels a day. This plant has had a peak capacity as high as 170,000 barrels of 7,140,000 gallons a day. About 40,000 barrels of water are treated daily to reduce the hardness as to make it more suitable for field use, especially in field boilers.

Gas fuel requirements in a drilling well will average between 400,000 and 500,000 cu. ft. a day.

When brought to its ultimate development, the Oklahoma City field will probably have witnessed an era of accomplishment in good drilling practice in hard formations and methods of well conrol that will mark them as a distinct advance in oil field practice.

Varying Motor Oil Performance Found In Tri-Motor Plane Consumption

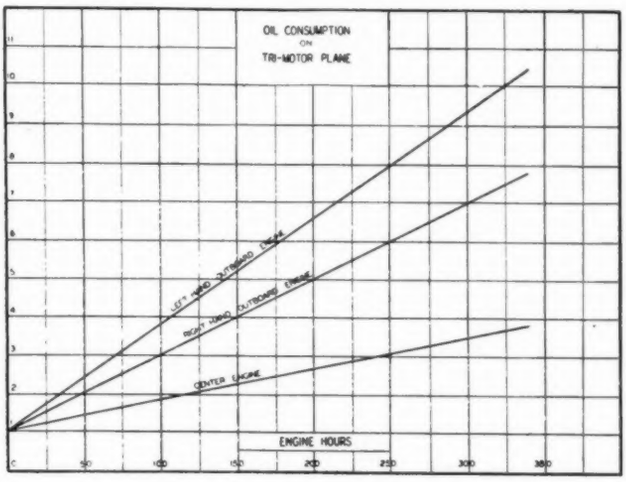
By WARD F. DAYTON, *Aviation Engineer*

IN the operation of a tri-motor airplane, performance data shows that there is very noticeable difference in the oil consumption in each of the three engines. The data in this article is based on the actual performance records covering a period of several months on a plane powered with three Wasp engines. The oil used was a paraffine-base aviation oil having a viscosity of 120 seconds Saybolt at 210° F. The oil was changed after each twenty-five hours of flying.

A careful study of the difference in the oil consumption of each of the three engines showed that it depended on the location of the engine, and action of the air displaced by the propeller. In the operation of tri-motor airplanes, there exists a very noticeable difference in the oil consumption of the three engines. This has been carefully checked and its causes were found to be in the location of the engines and the action of the air displaced by the propellers.

The records of a tri-motor plane, in everyday passenger service, were checked and a curve drawn of the oil consumption on the three engines. Fig. 1, this curve shows the highest consumption, in pounds per hour on the left hand outboard engine with right hand outboard next and the center engine shows the lowest. The oil used was a very high grade product, the service was over a period of time embracing both hot and cold weather.

The location of the three engines on a tri-motor plane are, one in the nose or front end of the fuselage and one on the right and left sides of the fuselage, under the wings slightly forward of the leading edge. These wing or outboard engines are several feet to the rear of the center engine.



Capt. Larry Fritz of the Safeway air lines (left), and Mr. Dayton (right)

Due to the pitch and direction of rotation of the propellers, the air they displace travels to the rear in a whirling motion, much like a horizontal whirlwind. Its direction of rotation is the same as the propellers (clockwise from the pilots' seat). It also travels at an oblique angle to the center line of the fuselage as it leaves the propeller.

The air from the propeller, on its way to rear, carries with it any dust or grit picked up or disturbed while the engines are idling, being warmed up taking off or landing the plane. Traveling with this whirling motion at an oblique angle to the left, the air from the center propeller goes down on the right side of engine and cowling and under the fuselage into the air stream of the left hand engine. This air with its load of dust and grit is sucked into the cylinders thru the carburetor, and there is mixed with the oil—increasing the wear on the reciprocating parts of the engine, which in turn lets greater quantities of oil past pistons and rings to be burned.

The right hand outboard engine gets the benefit of only a small amount of the air, with its dust and grit, from the center propeller, and this is that which is deflected from the right side of the fuselage.

These outboard engines also suck quite a bit of dust and grit into their cylinders, that is disturbed by their own propellers. Whereas the center engine sitting higher up from the ground than either of the outboards, gets none of the dust or grit disturbed by them and little or none from its own propeller.

When writing S. R. DRESSER MFG. CO. *please mention The Petroleum Engineer*

An Analysis of

Oil Field Electric Power Rates

By T. D. WILLIAMSON

WITH the continual increase in number of applications of electricity to the oil industry, greater interest is being manifested by executives and engineers in the various subjects relating to this source of power. More thought is being given to the proper types of electric motors, such as induction or synchronous, high or normal torque and to proper voltages, etc. The subject of power rates is given serious consideration, for it is of paramount importance, since in practically every new installation this is the deciding factor as to the economy and feasibility of electric drive, as compared with other types of prime movers.

T. D. Williamson

Considerable confusion appears to exist among executives, field superintendents and engineers as to the utility company's power rates for, of necessity, they contain certain terms and phrases peculiar to electricity. The object of this article is to furnish clear explanations of these terms; to give an analysis of the application of power rates to different types of oil field loads; and to offer suggestions as to how the cost of electric power may be minimized by the selection of proper motors, scheduling of loads, etc.

Explanation of Terms

In general, utility company power rates may be divided into five sections as follows:

(A) Demand Charge
(B) Energy Charge
(C) Adjustment for load factor
(D) Adjustment for power factor
(E) Fuel Clause

More than the above provisions are seldom used, and power rates do not necessarily contain all of the factors listed. Commercial managers of the large utility companies are striving to simplify their power rates, and to eliminate as many of the variable conditions as possible.

The following brief and simple explanations of the above clauses are offered:

(A) Demand Charge:

This charge has reference to the total amount of horsepower in motors, for which the power company is to supply electric power. It is easily understood that the larger the connected load, the greater capacity in transformers, transmission lines and reserve in electric generators which the power company must provide. If a customer has a load of large horsepower, operating, but a relatively short time each month, it would be unprofitable to the power company, and this clause is used to compensate for such a condition.

The "maximum demand" upon which this charge is based, may be determined in several ways. In some power rates, the horsepower rating of the motors as determined from the manufacturer's name plates, or a percentage of this horsepower rating, is used for this purpose. The most common means now employed is by use of a demand meter. This meter operates in connection with the power meter, and is so designed that it will register the maximum continuous load required from the electric power lines for a fixed period of time—usually fifteen or thirty minutes. This meter does not, therefore, register the power required for the short starting period of the motors, nor heavy loads of short duration.

(B) Energy Charge:

This charge represents the cost of the actual energy consumed, as indicated by the power meter. This energy is not in proportion to the horsepower rating of the motors, but to the mechanical output of these motors. For example, if the actual mechanical output of a fifty horsepower motor were but twenty-five horsepower, the power meter would register in proportion to the twenty-five horsepower load.

Power rates are usually based upon a sliding scale, starting with the maximum unit rate, for the smaller quantities of power used, and decreasing for the larger units.

(C) Load Factor:

Load factor is defined as the ratio of the total possible power used during a definite period of time, to the actual power consumed. For example, if a one hundred horsepower motor were operated continuously at full load for one month (720 hours), 72,000 horsepower-hours of energy would be consumed. This would be considered 100% load factor, for the full capacity of the motor was used during the entire number of hours in a month. If, however, the full capacity of the motor were used but half the number of hours in a month (360), the power consumed would be 36,000 horsepower hours. Dividing 36,000 by 72,000 would give .50 or 50%. From another standpoint, if but half of the capacity of the motor, or 50 horsepower, were used for the full number of hours in a month (720) the power consumed would be 36,000 horsepower-hours, which is also equivalent to a load factor of 50%. In other words, to secure 100% load factor it is necessary for a motor to operate continuously at its rated horsepower for the full number of hours in a month; and any variation in either horsepower output or operating hours will decrease the load factor proportionately.

In calculating the "load factor" for an electric power bill, the "connected load" or "maximum demand" is determined by the methods explained under the section entitled "Demand Charge." If the name plate rating of the motors is used, this rating is multiplied by .746 (1 horsepower equals .746 kilowatts) which reduces the horsepower to electrical terms. This figure multiplied by the number of hours in a month (720) gives the total amount of energy which could be used. If a demand meter has been installed by the power company, its reading multiplied by the number of hours in a month, will also give the total amount of energy which could be used. In either case, this maximum power figure divided into the actual power used, as determined from the power meter, will give the "load factor."

The reason utility companies are interested in this factor is an economic one. As mentioned under the section entitled "Demand Charge," the power company must provide capacities in its equipment for the entire capacity of a customer's load. If this equipment is operated at its full capacity continuously this brings a return on the investment which enables the power company to reduce the charge for its services.

A motor-driven pumping outfit.

(D) Power Factor:

It is a well known fact that magnetism plays an important part in the operation of electric equipment. A certain portion of the power supplied to some types of electric motors is used for the purpose of magnetization. The remainder of the electric power supplied to the motor is consumed in producing mechanical power. The ratio of the amount of power required for "magnetization" to that used in producing "mechanical power" is termed "Power Factor." Certain types of motors and electric equipment require more "magnetizing current" than other types, which would serve the same purpose. For example, synchronous type motors require no "magnetizing current" from the power supply, since they are provided with small direct current generators which supply this current.

The power required for magnetizing purposes does not register in a power meter, hence it is necessary for the power companies to provide another means of adjustment for this service. This is usually arranged on a percentage basis. For example, the power rate may be based upon the power company supplying 20% of the total energy consumed for magnetizing power. This is then considered a "normal" condition, and is called "80% Power Factor." If more than 20% of the total energy is required for magnetizing purposes, an additional charge is made for this service. If less than 20% is required, a rebate on the power charge is made. This adjustment is sometimes made by allowing a reduction of one per cent of the power bill for each per cent of power factor above eighty, and charging one per cent additional to the power bill, for each per cent the power factor is below eighty.

(E) Fuel Clause:

The largest single item in the cost of generating electricity in a central power station is that of fuel. It is, of course, necessary to base costs, and consequently power rates, on a certain assumed fuel cost. Where power rates are reduced as low as possible, fuel costs may fluctuate considerably, and the customers are given the benefit of economies, it is necessary to incorporate in the power rates the fuel cost upon which they are based, with a schedule giving the per cent of increase or decrease in rates, corresponding to certain charges in fuel costs.

Application of Power Rates

The oil field power schedule of a well-known utility company, based upon a limited number of pumping wells, is as follows:

(1) *Demand Charge:*

$2.00 per month per connected horsepower. For beam well pumping, the demand charge is $20.00 per well per month.

Energy Charge:

First Kilowatt hours per month per horsepower connected (or 250 K. W. H. per beam well) at 4.0c per K. W. H.
Next 5,000 K. W. H. per month at 2.5c per K. W. H.
Next 10,000 K. W. H. per month at 2.0c per K. W. H.
Excess K. W. H. per month at 1.5c per K. W. H.
10% discount from total bill for prompt payment.

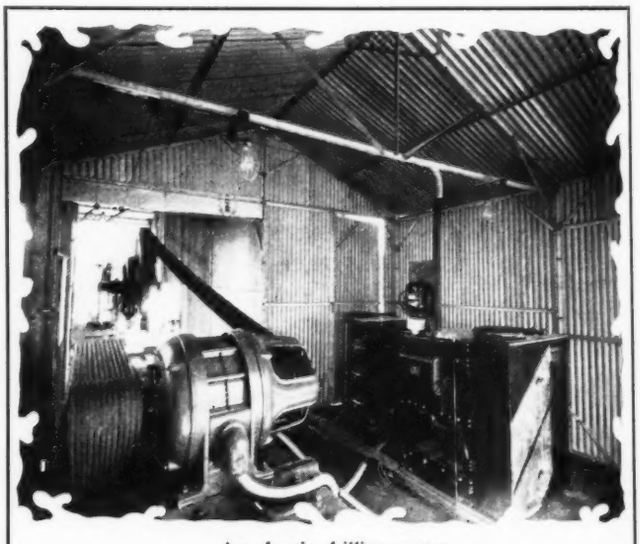
The cost of electric power, based upon the above schedule, will be calculated for a lease of eight pumping wells, operating under the following conditions:

Motor Rating—15/35 H. P., 600/1200 R. P. M., 440 volt.
Pumping Time—12 hours per day.
Pumping Load—15 H. P.
Rod Pulling—Once per month per well, requiring 6 hours at 35 horsepower.

Pumping Operation:

According to electrical calculations:

1 horsepower = 746 watts.
15 horsepower = 11,190 watts or 11.19 Kilowatts
11.19 × 12 (hours) = 134.24 Kilowatt hours. The amount of power consumed per motor in pumping 12 hours.



An electric drilling motor

134.24 × 30 (days) = 4027.20 Kilowatt hours. The amount of power consumed per motor per month in pumping.

4027.20 × 8 (motors) = 32,217.60 Kilowatt hours. The amount of power consumed by 8 motors per month in pumping.

Pulling Rods:

1 Horsepower = 746 watts.
35 Horsepower = 26,110 watts or 26.11 Kilowatts.
26.11 × 6 (hours) = 156.66 Kilowatt hours. The amount of power consumed per motor in pulling rods.
156.66 × 8 (hours) = 1253.28 Kilowatt hours. The amount of power consumed by 8 motors in pulling rods.

Combining the above power consumption:

Total power required for pumping	32,217.60 K. W. H.
Total power required for pulling	1,253.28 K. W. H.
Grand total	33,470.88 K. W. H.

Applying the above to the power rate (1).

Demand Charge:

8 wells @ $20.00 per well per month	$160.00

Energy Charge:

First: 8 motors @ 250 K. W. H. per well per month. 2,000 K. W. H. @ 4.0c per K. W. H.	$ 80.00
Next 5,000 K. W. H. @ 2.5c per K. W. H.	125.00
Next 10,000 K. W. H. @ 2.0c per K. W. H.	200.00
Excess (33,470.88 total power less 17,000, the total used in the above calculation) 16,470.88 K. W. H. @ 1.5c per K. W. H.	247.06
Total Gross Power Bill	$812.06
Less 10% for prompt payment	81.21
Total Net Power Bill	$730.85

Average cost of electric power per well:
730.85 divided by 8 equals $91.36.
Average cost of electric power, per Kilowatt hour:
730.85 divided by 33,470.88 equals 2.18c.

One of the large utility companies operating in the oil fields of West Texas has adopted a very simple power rate, consisting of but one step in the energy charge, no demand charge and with adjusting clauses for load factor and fuel cost. A summary of this schedule, which is applicable to compressor and pipe line pumping stations is as follows:

"Energy Charge":
1.35c per Kilowatt hour at 70% Load Factor, subject to Load Factor Adjustment.

"Load Factor":
Adjusting factor $\frac{70 - (70\text{-}X) .5}{X}$
Where X is the consumers Load Factor for the month.

The "Load Factor" is determined by dividing the total number of Kilowatt hours used, as indicated by the power meter, by the possible consumption in Kilowatt hours. This latter figure is calculated by multiplying the reading of a demand meter, operating on the basis of maximum continuous power consumed for a period of thirty minutes by the total number of hours in a month.

Fuel Clause:

The rates in the power schedule are based upon fuel oil at $1.00 per barrel. The energy rates will be increased or decreased .0035 of one cent for each 1% increase or decrease in the price of fuel oil, as stipulated above.

Calculation of power cost, based upon the above rates, will be made on a pipe line pumping station, operating under the following conditions:

Total power installation: 4—250 H. P. motors direct connected to centrifugal pumps.
Operating horsepower per motor 240
Operating hours per motor per month 700
Cost of fuel oil, 90c per barrel.

Calculation of Load Factor:

Actual consumption of power:
4 × 240 (H. P.) = 960 H. P. used in operating pumps.
960 × 746 (Watts) = 716.16 Kilowatts per hour.
716.16 × 700 (hours) = 501.312 Kilowatt hours actually consumed per month.

Possible consumption of power:
The Demand Meter would register:
716.16 Kilowatts as the maximum load.
716.16 × 720 (total hours in month) equals 515,635.20 Kilowatt hours. The possible power consumption per month:
501,312 ÷ 515,635.20 = .97 or 97% Load Factor.

Applying this figure to the Load Factor adjustment formula, we have: Adjusting Factor $= \frac{70 - (70\text{-}97) .5}{97} = .85$

A motor-driven pump station.

The power rate at 97% Load Factor would be 1.35 × .85 or 1.1475c per Kilowatt hour.

Adjustment for Fuel Clause:

Basis of power rates	$1.00 per barrel
Actual cost	.90 per barrel
Reduction in cost	$0.10 per barrel

or 10%

Applying the term under the fuel clause, the reduction in power cost would be .0035 × 10 or .035 per one cent of power rate, or

	1.1475c
Less	.0350c
	1.1125c per Kilowatt hour net cost.

Calculation of Power Cost:

Total actual consumption as above equals 501.312 Kilowatt hours per month, which at 1.1125c per Kilowatt hour equals $5577.10 monthly power cost.

The power rates of a large utility company operating in the Kansas oil field is somewhat more involved than the one just analyzed, but when the various clauses are carefully examined, they are not complicated. A brief summary of the power rate, applying to an average oil field drilling load is as follows:

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TROUT UNIVERSAL PITMAN
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SEASONS GREETINGS to the OIL INDUSTRY from LUFKIN
Manufactured at Lufkin, Texas, by
THE LUFKIN FOUNDRY AND MACHINE CO.
THE LUFKIN LINE
District Offices
Tulsa, Okla. Houston, Texas
THE LUFKIN LINE
Los Angeles, Cal. Seminole, Okla. El Dorado, Ark. Odessa, Texas New York, N.Y.

"Rate":

$2.00 net per month per Contract H. P. which $2.00 entitles consumer to use during such month 30 Kilowatt hours per contract horsepower.

1.5c net per Kilowatt hour for next 25,000 Kilowatt hours used per month.

1.0c net per Kilowatt hour for all additional energy used per month.

The contract horsepower for billing purposes is defined as the manufacturer's rating of the motors and other equipment, installed, to which shall be applied the following discounts:

100% of the first 60 H. P. of connected load.
50% of all additional H. P. of connected load.

Calculations will be made of a lease on which four cable tool drilling outfits are being used, consisting of the following electric equipment, operating under the conditions listed:

4—75 H. P., 440 volt, Variable Speed Drilling Motors operating at 45 H. P. an average of 16 hours per day. The larger horsepower demand, reaching 125 H. P. is for such short periods that the actual drilling requirements will be used in this calculation.

According to electrical formula:

1—horsepower equals 746 watts.
45—horsepower equals 35,570 watts or 33.57 Kilowatts.
4—Motors equals 4 × 33.57 K. W. = 134.28 Kilowatt power demand of 4 motors.
134.28 × 16 (hours) = 2148.48 Kilowatt hours power consumed per day.
2148.16 × 30 (days) = 64454.40 Kilowatt hours power consumed per month.

According to the terms of the power schedule, contract horsepower equals

100% of 60 H. P. equals	60 H. P.
50% of balance of connected load which equals 50% of 240 H. P. or	120 H. P.
Total contract H. P. for billing purposes	180

Applying the above figures to the schedule:

$2.00 per month per contract H. P. equals 2 × 180 = (Equal to 5400 K. W. H. in power consumption.)	$ 360.00
Next 25,000 Kilowatt hours @ 1.5c per K. W. H. =	375.00
Balance (64,454.40 K. W. H. less 30,400 K. W. H.) (which equals 34,054.40 K. W. H. @ 1.0c per K. W. H	340.54
Total net power cost	$1,075.54
Cost of electric power per drilling motor per month	268.88

Average cost of electric power 1.6c per K. W. H.

Economies Which May Be Effected

In designing a new electrical installation considerable thought should be given to the selection of the proper motors for the application and voltages which will minimize transmission line losses. In certain types of plants and power applications, the sequence of the operations can often be so scheduled as to keep the power requirements and the maximum demand to a minimum. The commercial representatives of the large utility companies are always very anxious to co-operate with their customers, in assisting them to minimize their power costs; for when electric drives are proven to be efficient and economical, the number of such drives will increase proportionately.

Selection of Motors:

As has just been mentioned, the selection of proper motors to meet the particular requirements of specific drives is of great importance in the economic operation of a station or plant. The most common mistake is in selecting larger motors than are actually required, resulting in:

(1) Too large demand charge.
(2) Poor load factor.
(3) Inefficient operation of the motor equipment.

The first two conditions have been explained in previous sections. Regarding the third condition, electrical equipment manufacturers design motors for the most efficient operation at full load. When electric motors are but partially loaded, both the efficiency and power factor characteristics become relatively poor. Frequently load conditions are such that a large amount of power is required to start the equipment in motion, while a relatively small amount is needed after it is in motion. To meet this condition manufacturers have designed motors with large starting capacity (so called high torque). By using this type of equipment, a motor may be selected to meet the full load running conditions. For machines requiring direct connected motors of relatively high horsepower and low speed, the synchronous type motor is best suited. At no increase in initial investment, higher efficiency and better operating characteristics are secured; and if high power factor is a consideration, this type of motor may be used to correct low power factor conditions. By giving some thought to the conditions briefly outlined above—and numerous other similar ones, which are peculiar to each individual installation, the power consumption, and such penalty conditions, which are usually found in electric power schedules, as large demand, poor power factor and low load factor, greatly reduced or eliminated.

Scheduling of Loads:

In certain types of plants and classes of loads, it is possible to so arrange the sequence of operation and the starting and stopping of motors, that a minimum of horsepower is connected to the power line at the same time. This result is a very material saving in power costs, for the demand charge is greatly reduced, and the load factor improved. A specific example of such saving is in the operation of a motor-driven pipe line system of one of the large oil companies. Operating conditions are such that it is not necessary for all of the motors to be running at the same time. The schedule of operations is so arranged that the number of motors connected to the power lines are kept to a minimum. In order to carry out this scheme, it is necessary to use automatic time clocks to start and stop some of the stations. The results are greatly reduced electric power costs—making the cost per barrel of oil pumped, a very low figure.

Conclusion:

Contrary to the general belief, and much evidence, it is the desire of the commercial managers of the large utility companies to simplify their electric power rates, and to remove from them any terms or conditions which may be ambiguous or confusing to their customers. However, the rapidly increasing use of electricity in all phases of the oil industry will bring familiarity with the common electrical terms, which are so necessary in its measurement and calculation; no longer will they seem strange or foreign to the executives and engineers who will constantly come in contact with them.

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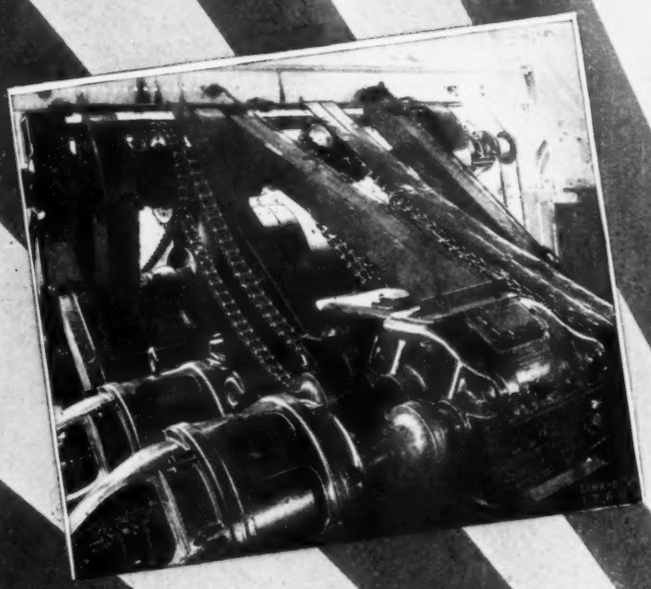

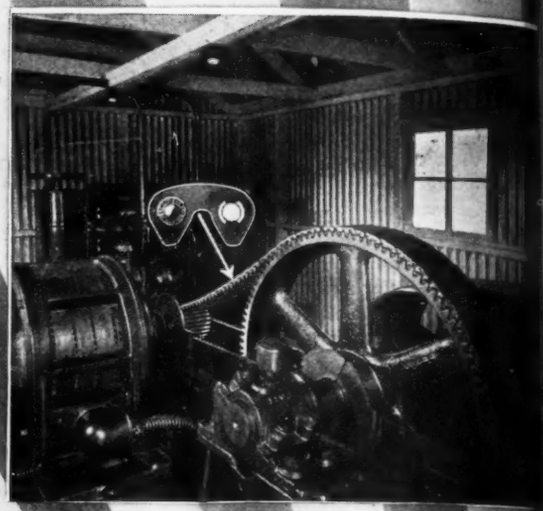

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Shipping Difficulties Created by the

Outage of Natural Gasoline

By EMBY KAYE,
General Superintendent, Natural Gasoline Department, Skelly Oil Co.

A GOOD deal of publicity has lately been given to the subject of outage as applicable to the natural gasoline industry. As indicated in several of the articles which appeared in trade papers, the Natural Gasoline Association, through the instrumentality of several of its committees, is endeavoring to crystallize opinion which will result in the recommendation of an outage code that will be fair alike to manufacturer and buyer. The present outage practice is as obsolete as it is unfair, and should be as much out of the marketing picture of today as is the unbranded casinghead gasoline of yesterday.

Natural gasoline has a very definite place in the motor fuel resources of this country, both by reason of the volume of its production and the characteristics of this product. It is said to represent 12 per cent of the total motor fuel produced in the United States at this time, and its use as a blending medium makes available as motor fuel large quantities of heavy naphthas which otherwise could not be marketed through the avenues of motor fuel. The characteristics of current natural gasoline will herein be described, and its value demonstrated in order to show the inequity and waste involved in the present-day practice of allowing outage indiscriminately.

Finished or stabilized natural gasoline, while varying in constituent composition, is essentially a physical mixture of the butanes, pentanes, and heavier hydrocarbons. A representative grade, AA for example, may contain approximately 30 per cent butane and 70 per cent pentanes and heavier. All of this material has a definite value as a fuel. Practically every manufacturer is prepared to ship a gasoline of this general composition.

A far different material was manufactured before the era of rectification. Let us take a representative unstabilized product from Seminole. We find 0.75 per cent ethane, 10 to 15 per cent propane, 25 per cent butane, 30 per cent pentanes, and the balance hexanes and heavier. There is probably not one gasoline manufacturer extant who will seriously claim that a material consisting of these constituents in these proportions is a desirable merchantable product and that it has utility as a blending agent. The best minds within the industry have been devoted to a study of the utility of the several constituents of natural gasoline and have come to the conclusion that the presence of a large propane percentage in this product would not be conducive to the building of a good motor fuel. They, therefore, have evolved manufacturing processes in which the presence of ethane is completely eliminated and the percentage of propane and butane definitely delimited.

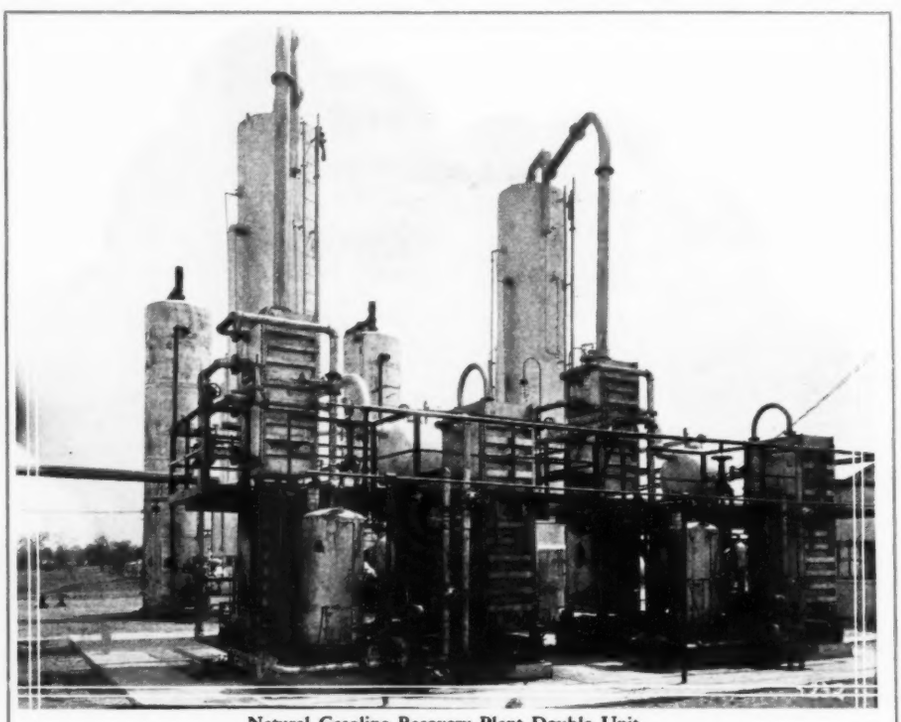
I. RAW GASOLINE.

Compound	Volume Per Cent
Ethane	.72
Propane	13.69
Iso-Butane	4.74
N-Butane	23.71
I-Pentane	10.43
N-Pentane	21.19
Hexane plus	25.07

II. STABILIZED GASOLINE.

Compound	Volume Per Cent
Ethane	.....
Propane	.51
Iso-Butane	4.42
N-Butane	24.06
I-Pentane	13.18
N-Pentane	18.19
Hexane plus	39.64

While it is no doubt true that all of the technical men are not agreed as to what extent propane should be limited, it may safely be stated that not one would be found who would favor a propane percentage such as is to be found in the above example I, of raw gasoline. The difference of opinion—and it is chiefly opinion, because of the inadequacy of tests—is rather as between propane free and 2 or 3 per cent. It is certainly too early to predict what will be the conclusion of the present inquiry into this question, yet it is more than likely that 1½ per cent of propane will be considered as practically propane free—if, of course, an excess of butane is not packed into the product.



Natural Gasoline Recovery Plant Double Unit.

Investigations carried on during the past few years have developed the utility of butane in motor fuel. The findings of such investigators as Dr. Brown, of Michigan, are too well known to need recapitulation here. It might

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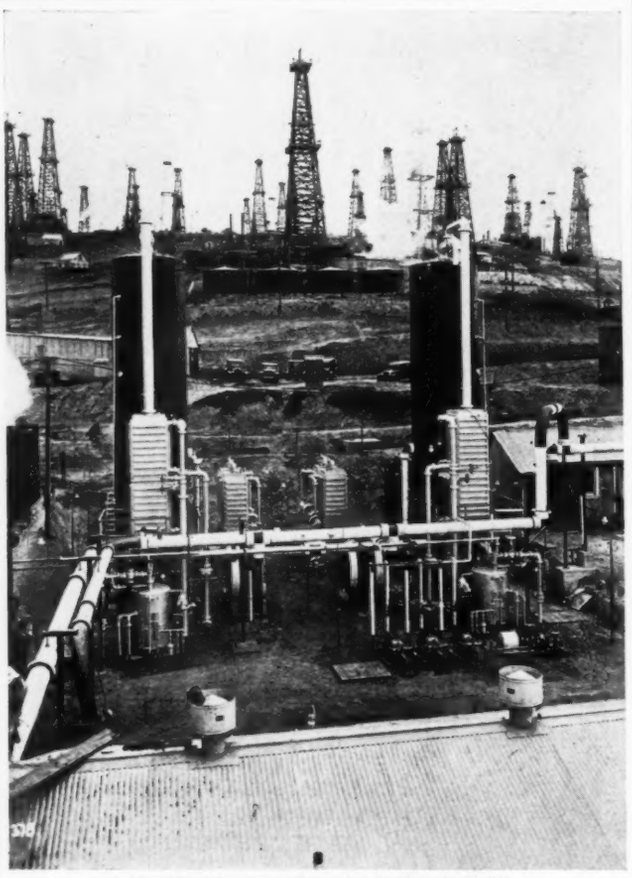
simply be stated that for average conditions up to 12 per cent butane in motor fuels may be used without danger of vapor lock, and with such decided advantages as easier starting, quicker acceleration, diminution of crank-case dilution, and less detonation. Tests by Dr. Brown and other investigators have shown that butane and pentane are the components of natural gasoline that make for these characteristics, hence rating them as the most desirable hydrocarbons in natural gasoline. They have also shown that a limited amount of propane is not harmful, and that 1 per cent of propane has the volatility effect of from 4 to 5 per cent of butane. The propane, however, is so readily volatile that its presence in large quantities may cause excessive losses due to evaporation on the one hand, and may bring about vapor locking on the other. When, however, it is considered that natural gasoline is blended with naphtha in varying percentages only up to 33 per cent, it will be seen that the finished fuel will contain only .5 per cent propane if the natural gasoline has 1.5 per cent, a percentage without harmful effects. Of course, if it is desired to increase the natural-naphtha ratio, a natural gasoline containing less than 35 per cent butane will be used.

We see, therefore, that when a refiner or jobber buys natural, he buys volatility, and in many cases benzol equivalent. The hexane in each car of natural gasoline is so much body or carrying agent for the volatility constituents. The writer can state upon the most reliable authority that a number of the largest buyers of natural gasoline stipulate products containing the highest butane content, for they buy naturals for volatility, and it is the function of the butane to provide that volatility. The greater the ratio of volatile constituents, the less freight the refiner or jobber pays on heavy ends, which add no particular characteristics and which may be wanting in the refiner's or jobber's naphtha. It follows, therefore, that it is decidedly to the refiner's or jobber's advantage to get into his tanks every drop of volatile hydrocarbons which arrives at his unloading rack in the manufacturer's tank car.

If a car upon arrival at the buyer's plant is opened up and allowed to weather, or if the pressure is released upon this car, what takes place? Such pressure as exists is due to the vapor pressure of the "stabilized gasoline." The gauge pressure on the car at the time of loading may have been almost atmospheric, but in transit, as the temperature of the gasoline tended to approach atmospheric, that gauge pressure may have risen to four or five or even seven or eight pounds. The refiner or jobber, upon noting this pressure, reflects that the gasoline is "wild," and that it no doubt contains large percentages of ethane and propane, and proceeds to "let off" the pressure. The sudden release of pressure naturally causes the liquid to boil with the result that not only the butane, but large percentages of pentane and heavier hydrocarbons are mechanically carried over into the air with the butane, which naturally will vaporize at around 33° F. if it is exposed to atmospheric pressure.

Thus the volatile non-volatile ratio is reduced, and the refiner, while not paying for what is lost, pays freight on a greater volume of heavy fractions and obtains a diminished volume of volatiles. The buyer simply must recognize the fact that natural gasoline containing these hydrocarbons is a volatile liquid manufactured at higher than atmospheric pressures, and that until it is absorbed by, or blended with naphtha or heavy gasoline whose volatility it is designed to increase, it must be handled under pressure if loss and waste are to be avoided.

Certain it is that it cannot be assumed that gauge pressure on a tank car is due only to the pressure of butane. It may be due to propane or even ethane. The writer wishes only to destroy the myth that gauge pressure *per se* means "wild" or unstabilized gasoline. If this myth is destroyed, there is ample ground upon which seller and buyer may meet. As is well known, natural gasoline can be bought upon specifications which can be analyzed as to individual constituents, and by investigation the buyer can find thoroughly stabilized gasoline, as per example II, which contains no ethane and a definitely limited amount of propane—in this case .51 per cent. Finding this manufacturer, the buyer should so equip his plant as to be able to unload all of the natural gasoline he buys either into his tanks or into his naphtha. The buyer will not want outage, for he must realize that every outage claim is a loss to buyer as well as seller.



Gasoline Recovery Plant in California Field. Courtesy Southwestern Engineering Corp.

It will not be news to the reader that a great many of the larger buyers of natural gasoline are so equipped as to be able to salvage all of the vapors which are weathered off of tank cars, and that these vapors are used either as an additional gas supply for the vapor recovery plant or are directly blended with naphtha. Vapor lines are laid to the rack, and safety valves are raised by means of a special device which permits the vapors to be drawn off into the vapor gathering system.

As long as the inequity of this procedure is not recognized, this disposal of vapors works an economy for the refiner who appreciates the value of these lighter hydrocarbons as the writer sees such value. The question which he is propounding is: By what right does the buyer remove material from a tank car before he has gauged that material for the account of the seller, if by every test available to the buyer the material in the car is precisely of the constituent composition desired by the buyer and sold by the seller?

The writer has enough confidence in the fairness of big business to anticipate an early solution of this vexing problem, fair and just alike to manufacturer and refiner.

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Efficiency in

Diesel Engine Power Cylinder Lubrication

By JOHN M. McGREGOR

IN the oil industry, as elsewhere, competition is keener today than ever before. To meet this condition there has been a gradual rising of the standard of efficiency in all branches and more attention is being paid to details which, previously, passed unnoticed in many cases.

With a view to trying to overcome power losses in pipe line engines a considerable amount of work has been done in order to determine the best method of getting more satisfactory cylinder lubrication and thereby stop cylinder and ring wear which results in lowered engine efficiency.

It is not the cost of part replacement alone that enters into the question but there also must be considered the loss of power due to "Blow By"; a probable increase in fuel consumption, contamination of the oil in the crank case necessitating more frequent cleaning or even changing, etc.

John M. McGregor

There must always be certain losses and it is not contended that the cause or cure for cylinder leakage due to wear has been found, but certain features seem to have been established that would tend to prove that a better understanding of lubricants and the methods of application would do much to improve the condition of the working parts of the Diesel cylinder after long periods of use.

It would be impossible to attempt to deal with the subject of cylinder lubrication in its entirety in a short article. The actual choice of the type and quantity of oil to be used must be decided for each particular engine by those in charge but some of the salient points noted over a period of several years have been found to be applicable to a large number and variety of engines.

Destructive criticism has at no time any value but it has been found that where criticism of a constructive nature has been offered it has been accepted readily. With this end in view a few suggestions are offered, all of which have been tried and found to effect considerable improvement.

Where there is excessive wear in a liner there must be loss of power for no oil can ever replace metal wear such as occurs in a badly worn engine. In order to determine the rate of wear and make comparisons, a simple system of checking has been evolved and a basic figure of hours run per .001″ wear established and it is safe to state that where comparisons are made by using this method, surprising differences in wear will frequently be found. In one specific instance two engines, exactly similar in every respect, were operating side by side under the same conditions with approximately the same load factors and yet a difference in liner wear, equivalent to a ratio of more than four to one, was noted. An application of one of the suggestions that were found to give better results had been tried on the unit which showed up so greatly superior to the other. There is no definite data available to prove that anything other than better liner and ring life was secured but it is felt that any appreciable improvement in this direction must lead to a general betterment of conditions.

Assuming that proper quantities of the correct oil are used the method of application will now be considered and for this purpose the cylinder lubricating system might be divided into three parts, viz.: 1. The mechanical lubricator; 2. The oil lines; 3. The check valves. There is no doubt that the first of these three has received considerable attention for one has only to scan the advertisements of any trade journal to see the number of lubricators appearing on the pages and the same, in a lesser degree, might be said of the check valves but there seems to have been little attempt made to co-ordinate the two except in rare cases. Taking the entire system as a whole there still remains much to be done before a state nearer perfection is reached. Not only should a good lubricator be fitted but its position should be considered. The mere fitting of oil lines is not sufficient, their number, method of distribution and points of entry are of considerable importance and lastly, the correct type and position of the check valves are essential before good lubrication can be secured.

The first point mentioned is the position of the lubricator. This might appear to have no great bearing on the matter and, if everything else be right, perhaps the difference in position is not of vital importance yet various tests made over a number of engines of different makes, types and sizes would go to show that in many instances considerable improvement has been secured when the mechanical lubricator is moved to a position lower than the point of entry of oil to the cylinder. In the case cited earlier where a gain of more than four to one was secured the only thing that was done was to move the lubricator from its original position on top of the cylinders to a position below the check valves. It would be difficult to state, with any degree of accuracy, just why this should be but it is felt that there exists a combination of circumstances. In this particular instance probably the contributary cause was faulty check valves. It is believed that with the lubricator in the upper position and leaky check valves in the cylinder there is much greater likelihood of getting rapid wear than if there were poor check valves in conjunction with a lubricator that is situated in the lower position.

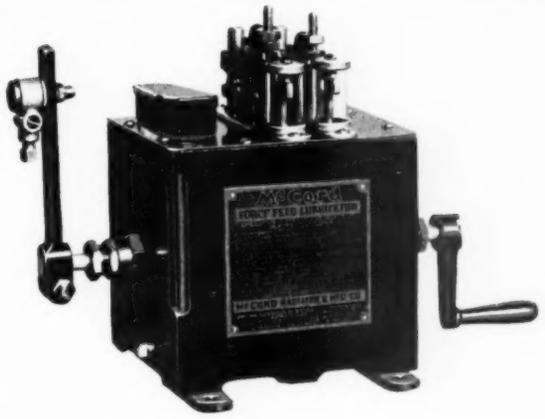
Some time ago while an engine was being checked for wear the lubricator, which was mounted on top of the cylinders, was turned by hand in order to fill the lines and show whether or not all the oil ports were open. The manual turning of the lubricator was considerably quicker than it would have moved had the engine been running yet it was noted that nearly twenty minutes were required to fill the lines in order that the oil would appear inside the liner. This occurred despite the fact that the engine had only been shut down for a short time and there was nothing found, either in the lines or oil ports, that would cause obstruction. The case cited is by no means an exceptional one for several of a similar nature have been met with. Were such a condition to exist while operating as, for example, had the engine been shut down for some time and

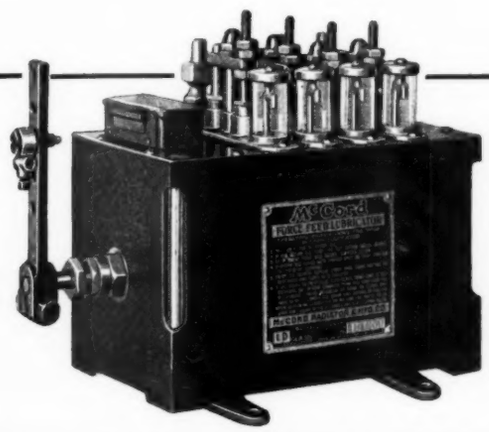
McCORD FORCE FEED LUBRICATORS

McCORD CLASS "LD"

Two Feed, 2 Qt. Capacity

It's an inherent characteristic of McCord Lubricators to deliver minute quantities of oil against high pressures. The pumping units can be adjusted to deliver quantities of oil varying from a fraction of a drop to a constant stream. Adjustments once made remain unchanged. They are not affected by extreme temperature changes. They deliver the same quantity of oil, regardless of viscosity.





McCORD CLASS "LD"

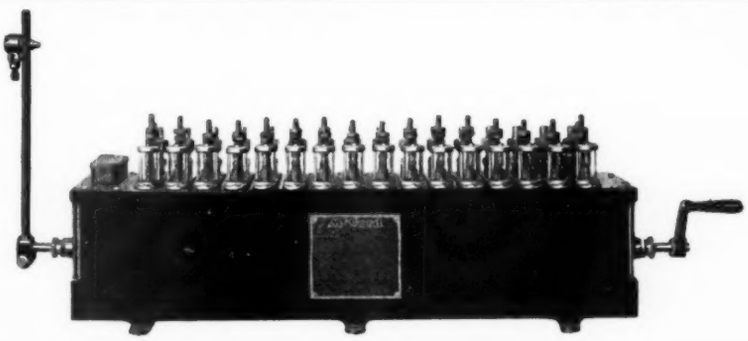
Four Feed, 1 Gal. Capacity

A McCord Lubricator is the only one of its kind that shows the oil actually being delivered to the cylinder or part being lubricated. Another safeguard that makes for dependable service is that undetected leakage is impossible. The construction of McCord Lubricators makes immediately evident any leaks, since oil will accumulate on top of the reservoir.

McCORD CLASS "LD"

Nine Feed, 2 Gal. Capacity

All McCord Lubricators are equipped with hand crank for hand flushing, reservoir filler cap, drain plug fitted at bottom of reservoir, reservoir gauge glass, and, where desirable, two compartments for feeding different kinds of oil. The problem involved in selecting the proper lubricator makes it impossible to list standardized data.



McCORD CLASS "LD"

Sixteen Feed, 3 Gal. Capacity

McCord engineers will gladly co-operate and make the most satisfactory recommendations upon submission of your requirements. From one of the four McCord Class "LD" Lubricators a unit can be selected to meet any condition or service.

McCORD RADIATOR & MFG. CO.
LUBRICATOR DIVISION
Detroit Michigan

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no examination made, considerable damage might have occurred, moreso in this case, as no provision is made on the lubricator for manual operation. Before turning by hand the drive has to be disconnected and it can be readily understood that this condition will be prone to give rise to inattention on the part of some operators. The particular case mentioned happened on an engine having a piston speed of approximately 800′ per minute at normal speeds. Even allowing for the oil being delivered as quickly as it was done by hand each piston would have traveled something like 16,000′ with little oil or, in all probability, in the event of a shut down without examination, with no oil at all.

Inspection in cases like the above has invariably shown that the trouble is due to leaky check valves permitting the oil to drain from the line whenever the unit is stopped. If the engine be shut down for a considerable length of time the oil will drain down the pipe, past the check and be lost. If the lubricator were in the lower position, pumping the oil upward, this difficulty would practically disappear; check valves in the lubricators might leak but the likelihood of this happening is much more remote for, owing to the close proximity of the average cylinder check to the hot surface of the cylinder, trouble is more apt to be met with, moreso when it is considered that tests have shown that check valves, to be really effective, should be as close as possible to the inner face of the liner.

In connection with this subject there would arise the matter of lines becoming air locked but the newer type of lubricators seem to be overcoming this difficulty. In a short article it is difficult to cover all the ground fully and space does not permit the part of the subject dealing with the position of the lubricator to be treated further but it is fairly safe to assert that frequently when trouble is being experienced in the lubrication of Diesel engine cylinders, it can be remedied by moving the lubricator as suggested.

Next there comes the number of lines to each cylinder and the position of their points of entry. The former is largely governed by conditions such as the type and size of the engine but it is felt that no matter how many points of lubrication there be, each oil line should be entirely separate from the other. In other words, it does not appear to be a wise policy to take one oil line from the lubricator and divide it into two or more branches each going to a different point in the cylinder wall. In this direction also, differences have been noted where engines have been altered and supplied with separate feeds instead of split feeds. In one particular instance an engine had two feeds to each cylinder each line dividing in two giving four points of lubrication in the cylinder. Every time an examination was made it was found that some of the oil holes were clogged and this clogging was invariably accompanied by dryness and gumminess on the liner, piston and rings. The system was altered by fitting an extra lubricator, four separate lines were installed and, on examination after a month's run, it was found that all oil holes were open and the liner and piston were in excellent condition.

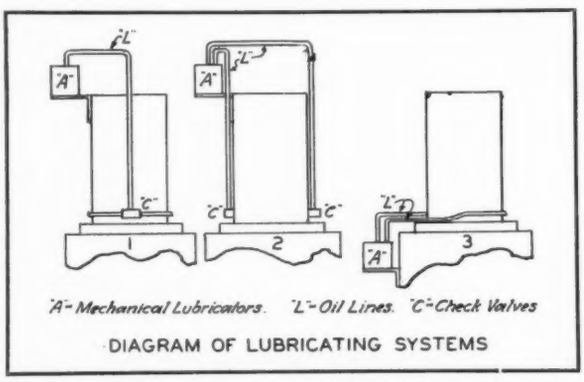


DIAGRAM OF LUBRICATING SYSTEMS

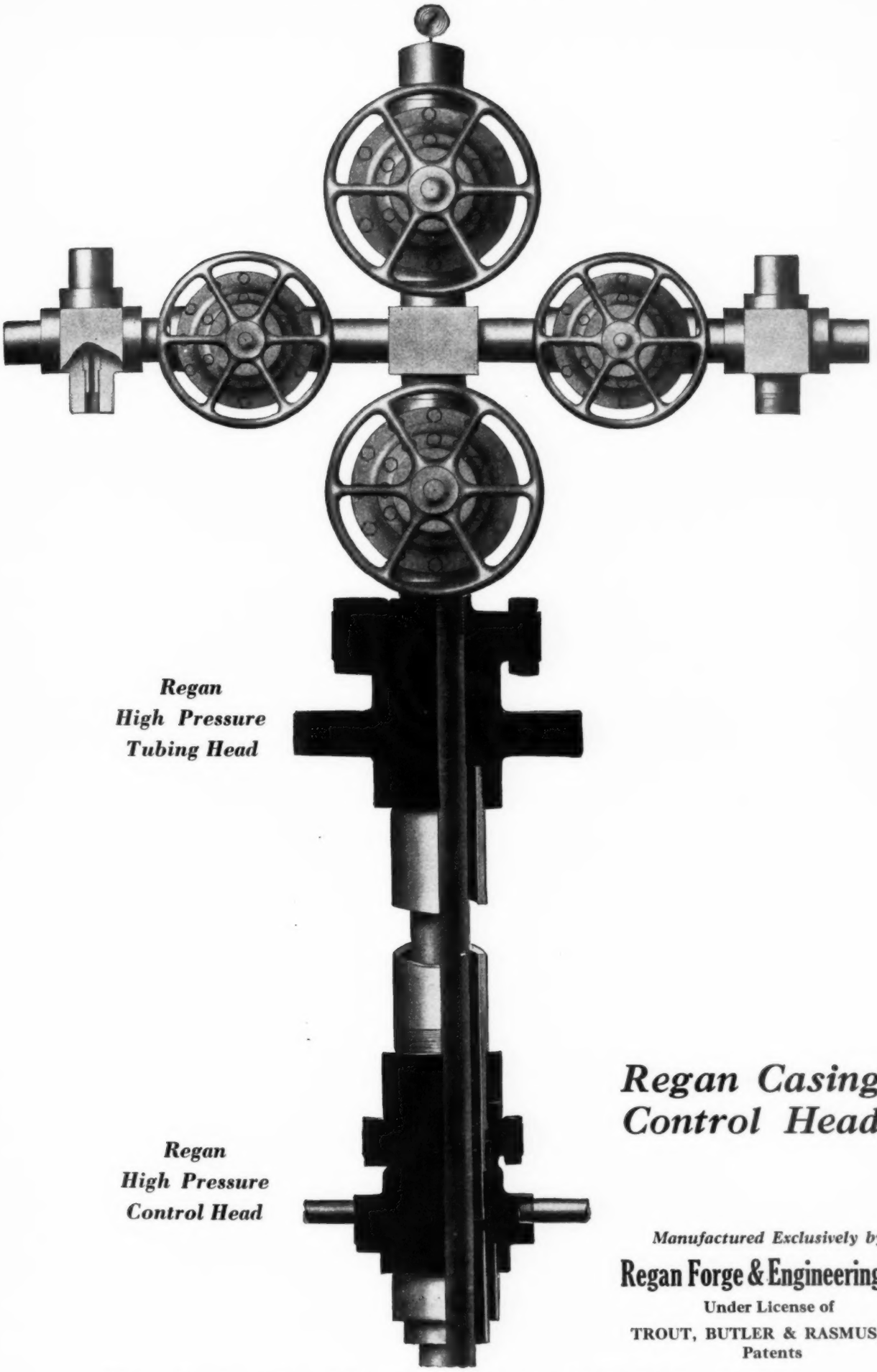
Opinions differ greatly regarding the position at which the oil should enter the cylinder, some prefer the top of the stroke, others the bottom or mid-way and there doesn't appear to be any definite information that would show just where the best point of entry is. In some instances manufacturers have so designed their engines that the oil hole is uncovered by the piston during part of the latter's travel. This may or may not be right but it seems that it would be safer to place the oil hole in such a position that would ensure its being covered by the piston at all times. A discussion of this point would bring up the question of timed lubrication which, in itself, would require considerable time to study and cannot be dealt with here. Suffice it to say that all experience gained has gone to show that timed lubrication is a difficult thing to achieve and furthermore it is doubtful if it is of any great importance, more especially in a well designed lubricating system. Of course where the piston uncovers the oil hole the entry of the oil should be capable of correct timing otherwise, as often as not, the oil might arrive to lubricate the liner and piston when the latter is not there to receive it.

Ball checks with springs are popular but these are not entirely satisfactory when placed close to the hot cylinder walls. It is not long before the spring loses its tension rendering the ball inoperative with resulting leakage of oil. A good check valve is essential to good cylinder lubrication for it not only keeps the oil from leaving the lines too rapidly but prevents the entry of hot gases which, when coming in contact with the oil, may reduce its efficiency.

The accompanying sketches show three methods of carrying the oil to the cylinder. Number 1 has the lubricator at a point higher than the oil hole with one oil line only going to the cylinder and entering a check valve where it divides into two branches. It is safe to say that this is not good practice, in many instances if one branch line be disconnected it will be found to be dry. It seems impossible to control the oil flow by this method and the result is poor cylinder lubrication with its attendant evils. Sketch number 2 shows a slightly better system. In this case the lubricator is still on top of the engine but two separate lines run from it to the cylinder. Again, in this instance, the system is not altogether satisfactory for we have the problem of leaking check valves to contend with and, with this arrangement, the loss of oil in the lines whenever the engine is shut down for any appreciable length of time added to which there is considerable space between liner and check in which the oil might become contaminated with hot gases.

Sketch number 3 shows the lubricator in a position lower than the point of entry of the oil, two separate lines enter the cylinder at 180° to each other and the check valves (not shown) are situated in the liner itself and close to the inner face. This combination is the best so far found although the number of lines is not necessarily two. In many instances four lines are fitted but, as stated previously, the number of oil lines will depend entirely on the engine to be lubricated. With the average cylinder of one hundred horse-power or thereabouts, the arrangement as shown in sketch three should give good results if the right amount of the right oil be used.

Many times the oil or the lubricating systems may be blamed for faulty cylinder lubrication when something altogether different might be the cause. All things such as the condition of the fuel pump, the valves, the amount of cooling water used and the condition of the water jackets must be considered for unless they are in good order no oil and no oiling system can give satisfactory cylinder lubrication.



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High Pressure
Tubing Head

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Corrosion and Erosion Problems of Sulphur Crudes

By C. B. FAUGHT,
Superintendent, Richardson Refining Co.

CORROSION and its side kick, erosion, are ever present problems in equipment used in refining any crude that contains sulphur compounds or salts. Few crudes are entirely free from these troublesome factors. Those crudes classed as "High Sulphur Crudes" naturally exhibit greater corrosive and erosive action than some of the "Sweet" crudes. However, the superiority of the gasolines made from the former class of crudes has been demonstrated to such a marked degree that refiners are attacking the bugaboo from a common sense angle and have accomplished a great deal towards minimizing the depreciation of equipment.

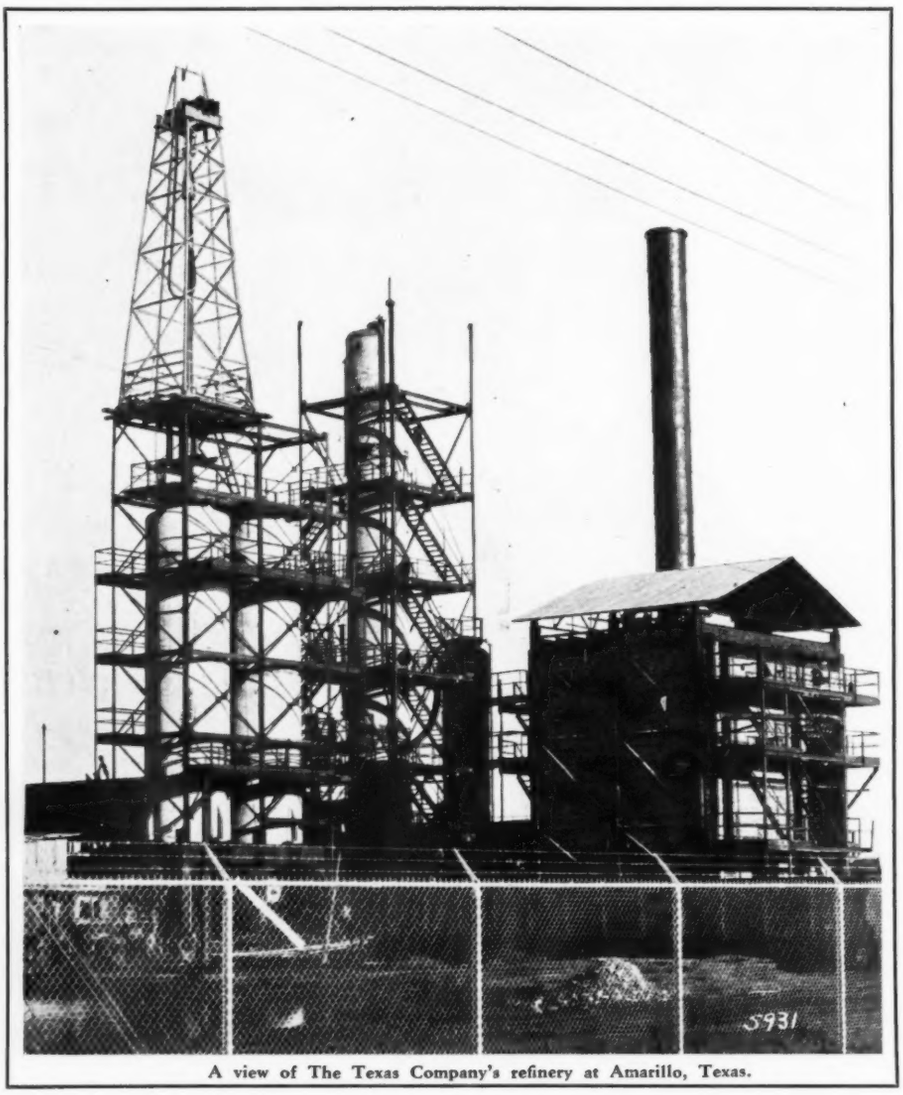
A correct understanding of the problems that are involved tends to materially reduce such depreciation. The problem of erosion is not so difficult as that of corrosion. The latter will also in due time be reduced to a matter of using the proper metals and neutralizers. This simple statement of fact is made despite the fact that corrosion is taking its daily toll and scrap piles accumulate.

Equipment manufacturers have worked with refiners on the development of special alloys that resist the action of sulphur, and in many cases it has been found that the best metals are less expensive than standard equipment. In other cases where extreme conditions are encountered, more expensive alloys must be used.

The problems have reduced themselves to a point where in order to properly apply the equipment, it is necessary to thoroughly survey conditions before purchase. This will save a large part of the material that will otherwise go to the junk pile. Contracting engineers who make a specialty of erecting complete units under contract have in many instances in West Texas failed to take these factors into consideration and have run into serious troubles, chiefly through lack of knowledge of the difficulties involved.

One metal that has proven a complete failure in high corrosive conditions is brass. It cannot be used in any place where it will be exposed to sulphur, either hot or cold. This is also true of bronze. All iron valves have given fair service and steel valves manufactured by reliable manufacturers give very good service. However, inferior steel valves give very limited and unsatisfactory service.

We have found the most satisfactory valve, and in fact the only kind that has given practically perfect service has been a special type valve. The uses of this type valve are limited, it is true, but many series are made, and when used in the particular service recommended by the manufacturer, seldom give trouble. They require attention and must be kept properly lubricated, but in return offer the best solution of the valve problem.



A view of The Texas Company's refinery at Amarillo, Texas.

The most serious corrosion and erosion takes place in the distillation unit. It is here that the hydrogen sulphide gas is released from the crude, and it is this gas which gives most trouble. This gas is present in the crude and begins its short but troublesome existence by eating up any part of the liquid end of the charging pump that is susceptible. Stainless steel liners and pump rods eliminate the trouble at this point, and all iron parts minimize it to a marked degree. It is true that the problem is not very acute as long as the crude is cold. Action is comparatively slow, except on brass and bronze.

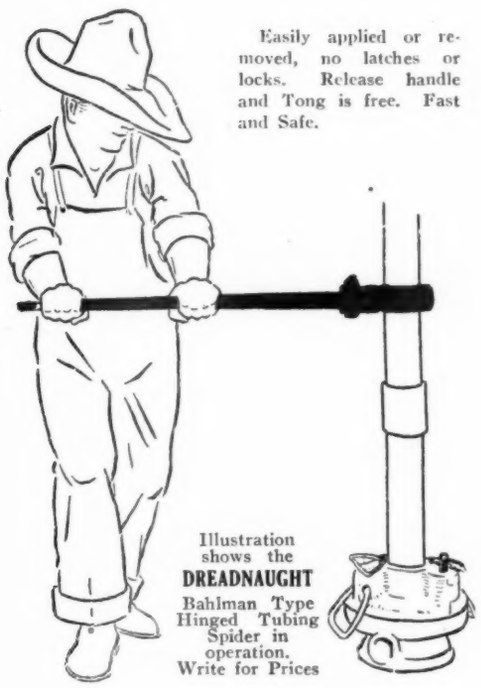
The action of

DIVIDENDS

Does the man in the field realize his importance and the relation his individual efforts bear on the successful growth of his organization, and to the reward due on the capital invested in making oil field activities possible?

We know he does. In every field of activity in the industry today there is a better feeling of individual responsibility for the successful operation of the property than ever before.

Assisting in the program of "successful oil field operation" the Dreadnaught "SPEED WITH SAFETY" Tubing Tong is playing an important part.



Easily applied or removed, no latches or locks. Release handle and Tong is free. Fast and Safe.

Illustration shows the **DREADNAUGHT** Bahlman Type Hinged Tubing Spider in operation. Write for Prices

A one-man tong. Swung into position with one hand; jaw closed with other. Used pass around or rachet wise. Performance is amazing.

"Teeth completely around the Jaw."

Light weight but extreme strength. Made of electric steel. Teeth are hand-sharpened, jaws heat-treated and hardened for long, hard service.

Instant grip—No crushing or swedging of the tubing. No dies or adjustments.

The various size jaws are interchangeable on one handle—all sizes of tubing handled by changing jaws

DREADNAUGHT TUBING TONGS

Sold by Your Dealer, by All Frick-Reid Stores or Direct

BEAUMONT IRON WORKS COMPANY

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BEAUMONT, TEXAS, U. S. A.

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salts, if present in the crude, begins in the heat exchangers. It is a simple matter, where heat is available, to bring the crude up above 300° F. in the line before it enters the tubes. If nothing is done to prevent the salts from dropping out, serious trouble soon develops in the exchangers. If salts are present in large enough quantity, passage is plugged and the tubes are pitted and eaten away. Even a trace of water in the crude is sufficient to cause hydrolization at this temperature, and as the passage becomes plugged, the flow of liquid decreases until all available space is filled. This slowing down allows time for action on the tube bundle, causing the surfaces to pit, which accelerates depositing and consequent action.

Several methods of combating this trouble are in general use. All are based on the injection of a neutralizer into the charge before it enters the exchangers. These are hydrated lime, caustic solutions, soda ash solutions and ammonia. The failure or success of each one depends on the method of operating the unit. Hydrated lime used in the correct amount, not only prevents corrosion in the distillation unit, but prevents the plugging of the exchangers. Experiments have shown that on a given piece of equipment, where no lime was used in the crude until the oil reached the tube entry, the tube bundles plugged in twelve days. An excess of lime lengthened the run to thirty days, but after several trials, a minimum amount that would just neutralize the effect of the salts was found to prolong the runs for several months. It also prevented the deposition of material in the tubes and kept the return bends in excellent condition, as well as minimizing the erosive action on thermocouple wells in the outlet line.

A West Texas road, sand as far as you can see.

Injection of lime in predetermined amounts into the suction of the crude pump has a very beneficial effect. The lime is best mixed in solution in a heavy gas oil or distillate cut and agitated to prevent settling out of the lime, and then fed to the charge by means of a proportioning pump. Screening the lime before mixing and passing the mix through an effective screen before it enters the charging line will prevent scoring the pump rods. The use of even a small amount of water in the lime mixing tank is very bad as it furnishes moisture for the chemical actions that take place later in the distillation.

The usual equipment for this lime solution is a small tank convenient to the charging pump, equipped either with an air spray or a mechanical agitator. It is a simple matter to keep the lime in suspension.

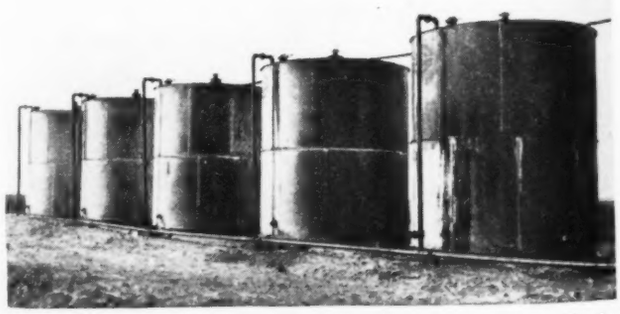
The addition of water in the lime solution is also impractical from an operating standpoint as it permits the formation of small steam pockets in the tubes. This expansion is both forward and backward, causing disturbances in the flow of oil in the tubes and permitting momentary vacancies in which small amounts of coke are deposited.

Properly neutralized, the corrosion in the tubes is very gradual. Return bends are protected, and unless excessive amounts of neutralizers, such as lime, are used erosion is very slight. It takes places in such exposed surfaces as thermocouple wells in the outlet of the still, but is not noticeable in the cooler oil at the inlet.

Corrosion is practically eliminated in the bubble tower and run down lines when steam is not used for stripping or when a dry distillation is carried on, and when the hydrogen sulphide gas is neutralized before the condensing temperature is reached in the vapor line. It is possible and practical to inject a solution of caustic, or anhydrous ammonia, into the vapor line before entering the condensing equipment. All of the sulphide gas can be neutralized. The resultant gasoline is sweet to the copper strip and to lead acetate. This is the end of the corrosion as far as the gasoline is concerned, as the resultant liquid is entirely non-corrosive.

However a more effective and less expensive method is the use of cold water instead of a neutralizer. Cold water absorbs large quantities of hydrogen sulphide gas. The most efficient temperature is between 60° and 65° F. Warmer water has less capacity for absorption. Water is pumped into the condensing equipment at the same point as the ammonia or caustic solution. The resultant gasoline will not be entirely non-corrosive nor will it be entirely non-poisonous, but for all practical purposes it will be in good condition for easy handling. The use of water is very simple and inexpensive. The water will continue to absorb the sulphide gas until its saturation point has been reached and can be circulated over the system until spent. The resultant gasoline is not sweet to lead acetate. When the stream is allowed to run sour, the run down tanks and storage tanks will be attacked by this gas, forming iron sulphide. This presents a fire hazard if the tanks are not tied into a gas recovery system. If air is admitted into the tanks when pumping out, there is danger of fires as the iron sulphide is oxidized. This is especially noticeable in floating roof tanks. As the roof is lowered, the oxide is formed rapidly. Even though there may not be enough oxidation to start combustion by the resultant heat generated, scaling of the tank walls takes place. In time the walls are eaten away. This trouble is remedied by proper application of cold water, and the cost of neutralizing the distillates is practically eliminated.

The corrosion problems presented by the fractions other than gasoline are not serious. The sulphide gas is very volatile and leaves the bubble tower with the overhead cut, which gives the side cuts or streams almost a neutral reaction. Painting the insides of the gas oil, kerosene or stove distillate tanks if corrosion is noticeable, will eliminate trouble with these fractions. Corrosion of cracking equipment presents very different problems which will be discussed at a later date.



DOWN in West Texas, where they have unusually bad soil conditions, storage tanks have been effected. The tanks in the above illustration were raised off the ground and placed on wooden deckings. This process is said to have been a great benefit in reducing the rate of corrosion.

The Cheaper the Sucker Rod—the More it Costs!

One deep well Sucker Rod failure costs far more than the difference between the *cheapest* and *highest priced* string of rods.

Jones Fully Normalized High Manganese Steel Rods represent the most modern practice—the finest quality rod ever produced—and therefore cost *less per barrel of oil produced.*

Jones original Acme Sucker Rods are cheapest per foot for pumping shallow (up to 2000') wells.

The S. M. JONES COMPANY

***Mid-Continent Office*: McBirney Bldg., Tulsa, Okla.**

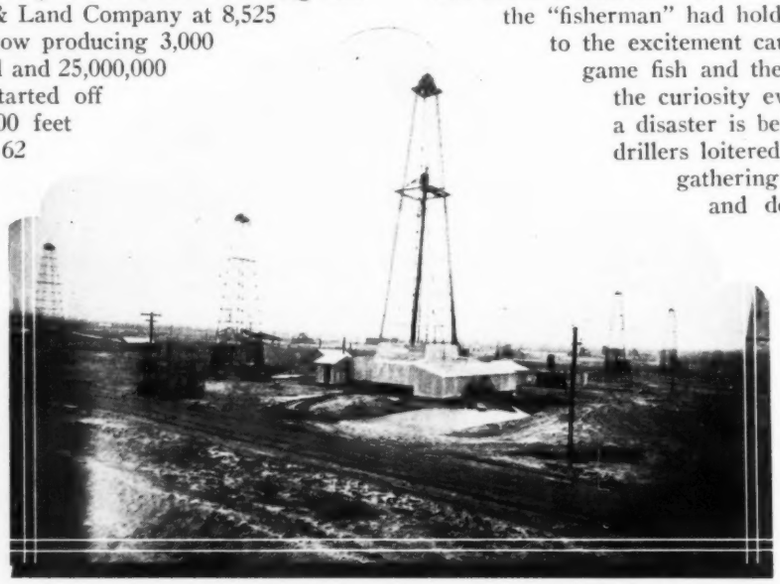
How They Cleaned Up

The World's Deepest Fishing Job

WHEN C. D. Hughes, the Isaac Walton of the oil industry, was called on to round out his enviable reputation as a well fisherman by cleaning up the world's deepest fishing job, he accepted but with much trepidation.

Unlike the grand old man of the sporting world who knew his bait when it came to making the finny tribe grab his hook, the oil industry's fireside yarn spinner, has to reverse the art. Figuratively speaking, he has to make his hook bite the fish.

Fishing in the oil country was more or less a prosaic art with enough difficult jobs to make it interesting until the cable tools bridged in an 8,379 foot hole down in that sweep of country, West Texas, where numerous real engineering problems have been met and mastered. This particular job resulted when the pay was unexpectedly encountered in the Big Lake Oil Company's No. 3-C in the Big Lake field, Regan County, Texas. This well is the second to reach the world's deepest producing horizon, the first being completed by the Texon Oil & Land Company at 8,525 feet last December and now producing 3,000 barrels of high gravity oil and 25,000,000 feet of gas. No. 3-C started off with better than 5,000,000 feet of gas and 180 barrels of 62 gravity oil and with the tools in the hole had a pressure of 1,850 pounds.



Big Lake Oil Co. well in West Texas where the world's deepest fishing job occurred.

Arriving on the job the afternoon of October 21 tension about the well was accelerated and prospects for success didn't loom bright when Hughes learned the fishing job was to be in a 4¼ inch inside diameter hole. One of those rare old types of philosopher, and incidentally a vanishing type, an itinerant shoe cobbler traveling in a car reeking with odors of burnt lubricants, informed him various drillers contended the hole could never be cleaned and would be junked.

The tools consisted of a 36 foot stem, seven foot bit, five feet of jars and a 2 foot rope socket, making a total of 50 feet bridged somewhere in the hole.

The well was first killed with water. A cementing outfit pumped the hole full of water, requiring four and a half hours. After this a fire hose was connected to the pump to keep, if possible, an uncertain column of fluid in the hole. Frequently the well gave evidence of preparing to lift the water column and start flowing and as fast as the water flowed out more water was pumped in. Once the well headed and sent a shower of water half way to the top of the derrick. However, these threats never developed to a serious degree and for the most part the water column was kept standing within five feet of the casing top.

After killing the well the wire line was cut with a jar up knife. After pulling out the severed wire about five feet of stranded wire was taken out with a two prong grab. After getting the stranded wire Hughes was sure the tools were on the neck of the socket because of marks on the inside of the two prong grab. Incidentally this permitted a measurement showing the tools to be 196 feet up in the hole at 8,183 feet.

It was first thought that possibly the bridged tools could be jarred down to the bottom of the hole but after trying this for 12 hours with long stroke jars and failing to move them Hughes ran a blind box to prepare the neck for a combination socket. This was done, the combination socket run, and the tools got hold of and jarred up 65 feet where they then swung clear. As soon as the tools swung clear they were pulled on out and the remaining wire fished out with a two prong grab.

The scene around the well when word passed around that the "fisherman" had hold of the tools was similar to the excitement caused by the landing of a game fish and the crowd gathered in with the curiosity evinced when the agent of a disaster is being moved. Some of the drillers loitered around the derrick floor gathering up courage to walk over and determine how it felt to "feel" a fishing job more than a mile and a half below the surface. It was estimated that approximately 150 people were on hand to watch such a prosaic thing as tools come out of the hole, but then not every one is privileged to watch tools which had caused the deepest fishing job on record being safely landed on the derrick floor.

The history of Mr. Hughes dates back to Pennsylvania where he pumped wells long before he was large enough to kick the engine off center. He learned to drill on his father's leases, who, incidentally, lived to be 91. On coming to the Mid-Continent 19 years ago he started in as a contractor and it was Mr. Hughes who drilled the first well put down in the Mid-Continent by W. G. Skelly. After a few years of drilling he sold his tools and specialized with Cy Munn in fishing for more than a year. During the many years he has specialized in cleaning up fishing jobs he has been called for jobs from the Canadian border to the Gulf and from the eastern fields to the western coast.

This particular job, however, he said, was similar to all others of its kind. It had to be handled much in the same manner as a job in a 4,000 foot hole, yet fishing in a 4¼ inch hole 8,379 feet below the surface is bound to make a man nervous.

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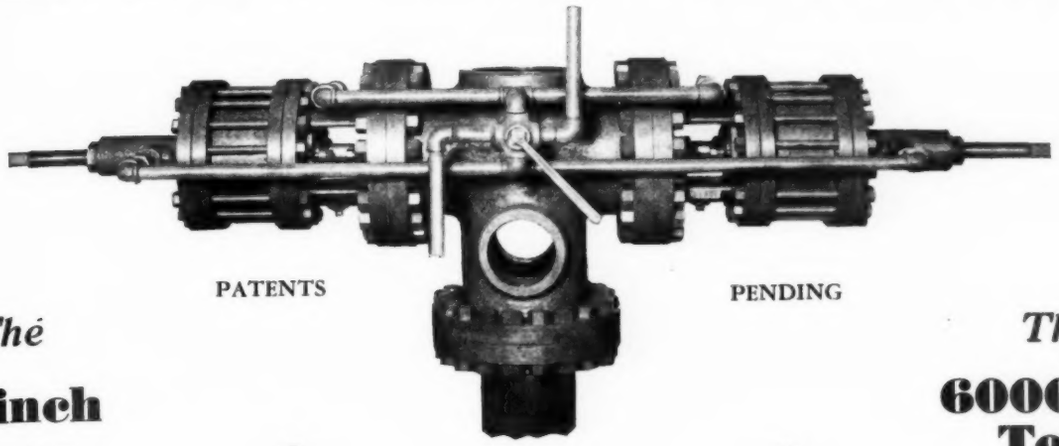
Announce—

A LARGER
STEAM OPERATED BLOWOUT PREVENTER
AND A
HEAVY DUTY TUBING CONTROL HEAD



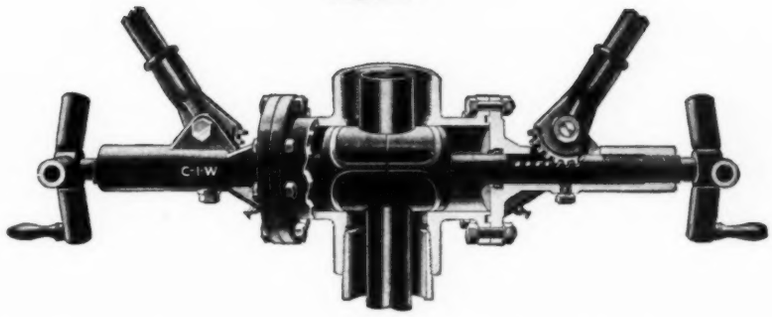
PATENTS PENDING

The

16-inch

STEAM OPERATED BLOWOUT PREVENTER

(Above)



The

6000 lb. Test

TUBING CONTROL HEAD

(Below)

With the introduction of this heavy duty control head it is now possible to run tubing under the heaviest pressures without killing the well.

This Control Head has steel rams, packed with our patented hydraulic rubber packing. These rams are operated by lever-jacks and lock screws, as shown on the accompanying three-quarter view of the Control Head.

By using two of these Heads, one above the other and opening and closing them alternately to allow couplings to pass, it is possible to snub in tubing against any pressure without killing the well.

For low pressures there is the 1200-pound test Tubing Control Head which has been extensively used for "tubing" wells developing less pressure than 1200 pounds per square inch.

This extra large preventer was designed to meet the demands of certain companies, whose operations required a blowout preventer sufficiently large to fit 16-inch A. P. I. casing. Reducing flanges are available in this size.

The design and working principle of this largest Blowout Preventer are identical with the smaller sizes of our standard Steam Operated Types.

It has the same 4-way operating valve; remote control; steel rams; patented hydraulic packing; 3000 pounds per square inch test and all other features that have made this Preventer without equal in oil fields today.

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American Installations Aid Materially in

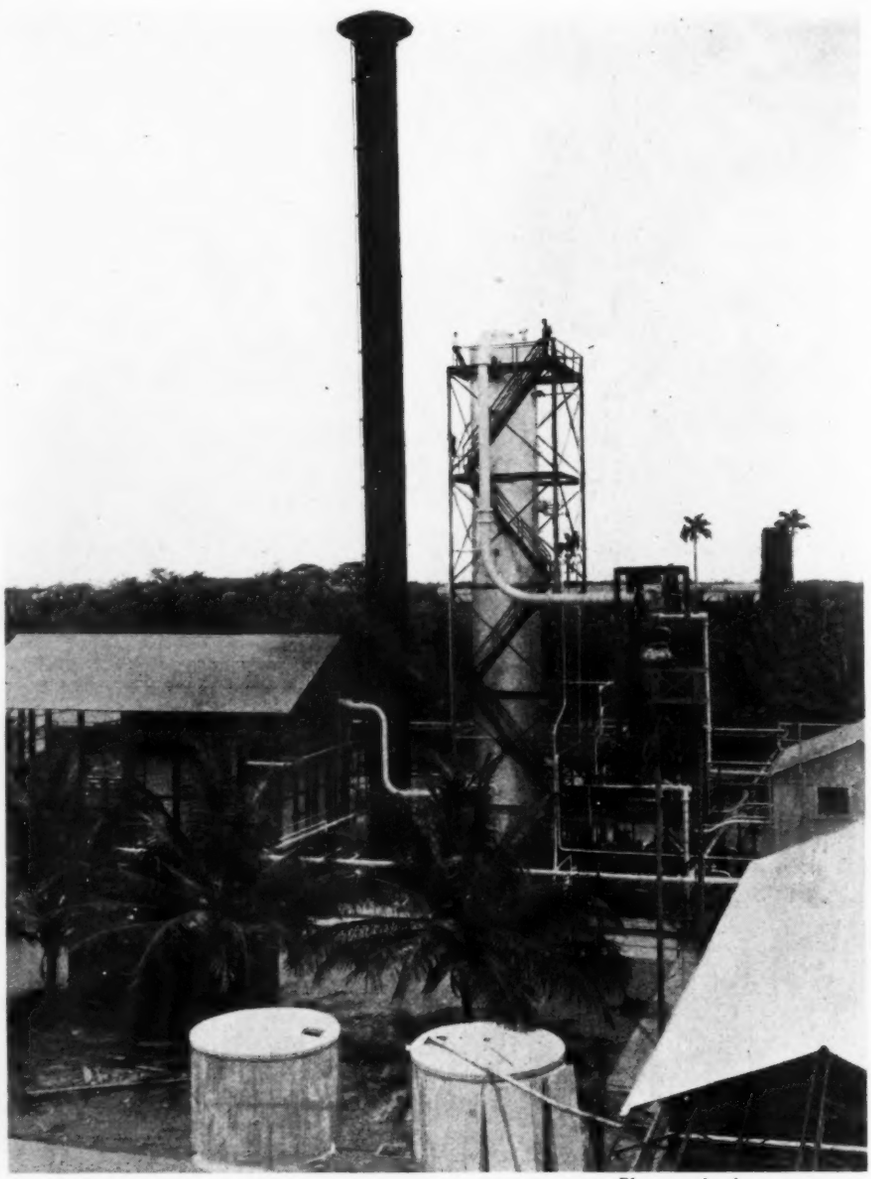
Refinery Engineering in Trinidad

Left—Three American flat cars carrying fractionating tower. Right — The same tower being transported to the refinery site. Below—Complete refinery unit erected in Trinidad.

AMERICAN engineering companies are building many complete refineries and units in foreign lands throughout the world. The skill, efficiency, and progressiveness of our engineers are well recognized by many of the oil companies of other countries, and they are installing the most up-to-date American built equipment. Very often the installations are of very large capacity. In many cases the first installations operated so successfully that the same construction company was given orders for additional units of even larger capacity.

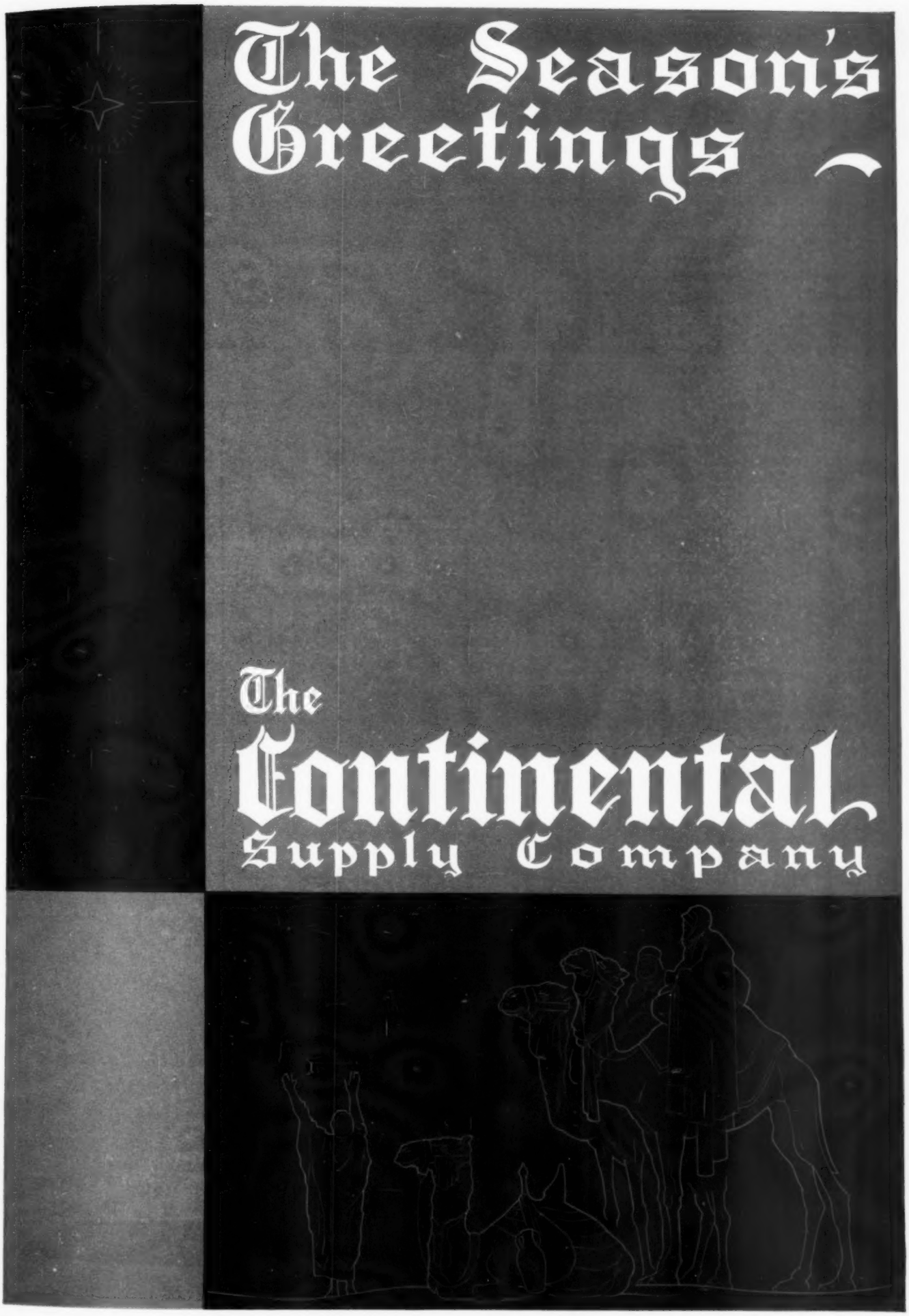
The erection of the heavy apparatus for refinery units very often presents great difficulties in certain portions of the globe. Many transportation and construction obstacles have to be overcome when the larger units are being erected. Regardless of this fact, the American engineer is invariably successful in overcoming all difficulties with the result that nearly perfect operation and performance is attained.

One small picture shows sections of a fractionating tower for a 10,000-barrel crude oil pipe still being transported from the dock to the refinery site. The tower was shipped from the shop in sections, each American freight car carrying two or three. And when these were unloaded from the steamer in Trinidad, one section was the maximum capacity of the small freight of the local railroad. The other picture shows a full trainload in Trinidad which was carried by three American flat cars.



—Photographs by courtesy of Foster-Wheeler Corp.

The large photograph shows a complete American refinery unit recently erected on the island of Trinidad for the Trinidad Leaseholds, Ltd. This refinery unit, built in tropical surroundings, has a through - put of 7,000 barrels of crude per day which is separated into gasoline, kerosene, gas oil and fuel oil bottoms. The distillation is accomplished in a single tube still, which heats the crude to the desired temperature, and a bubble tower, in which the various products are fractionated. The operation of this unit has been so satisfactory that a second and larger unit is now being built and will go into service in the near future.



When writing THE CONTINENTAL SUPPLY CO. *please mention The Petroleum Engineer*

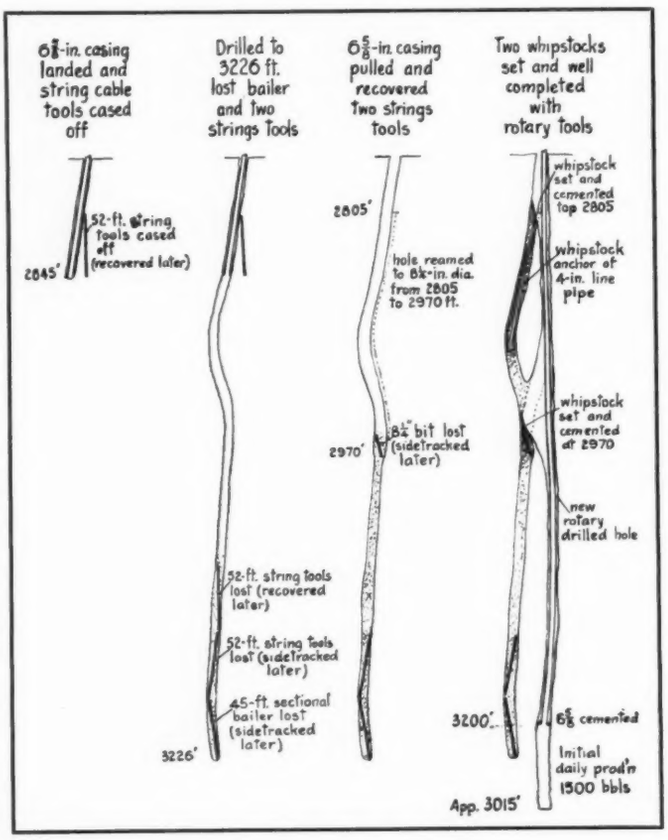
Well Successfully Completed After a

Difficult Whipstocking *and* Sidetracking Job

By HAROLD N. PARDEE*

SHEER persistence under the most discouraging conditions was solely responsible for the successful completion of a wildcat well in New Mexico. The well in question is the Texas Company's Shephard Permit No. 1, in Lea County, New Mexico, about three miles south of Jal.

This well had been drilled with cable tools to about 2,845 feet. It was found necessary, after a long, unsuccessful fishing job, to land the 6⅝-inch casing at 2,845 feet in order to case off the fish, a string of tools with 8¼-inch bit, two fishing socket bowls and some slips. Anticipating high pressure gas, the hole was filled with a heavy mud weighting fluid as a precautionary measure. Drilling progress was slow until after 2,905 feet was reached. At 3,212 feet, oil and gas were encountered. In the meantime, the mud weighting fluid was bailed from the hole and, at 3,226 feet, the well was spraying about 55 barrels of oil and four and a half million cubic feet of gas daily. At this depth, a 45-foot sectional bailer was lost. A fishing string 52 feet long with center spear was run to fish the bailer out. In coming out of the hole, the line on fishing string was cut off just above the rope socket, causing the fishing string to drop to bottom from about 2,845 feet, the lower end of the casing shoe. Another fishing string was run with a three-prong grab. Due to cutting of the line it also was lost.


6⅝-in. casing landed and string cable tools cased off
52-ft. string tools cased off (recovered later)
2845'
Drilled to 3226 ft. lost bailer and two strings tools
52-ft. string tools lost (recovered later)
52-ft. string tools lost (sidetracked later)
45-ft. sectional bailer lost (sidetracked later)
3226'
6⅝-in. casing pulled and recovered two strings tools
2805'
hole reamed to 8¼-in. dia. from 2805 to 2970 ft.
8¼" bit lost (sidetracked later)
2970'
Two whipstocks set and well completed with rotary tools
whipstock set and cemented top 2805
whipstock anchor of 4-in. line pipe
whipstock set and cemented at 2970
new rotary drilled hole
3200'
6⅝ cemented
Initial daily prod'n 1500 bbls
App. 3015'

The 6⅝-inch casing was then pulled and found to be badly line cut, also the string of tools, the fishing socket bowls and the slips that had been cased off, fell over in the hole. This string was fished out, the bowls and slips sidetracked, and the hole cleaned out to the top of the last string of tools lost below the casing shoe. It was found that some iron (slips lost farther up the hole) was lodged on top of the rope socket. This was milled off and another string of tools fished out. On top of the lower string it was found that in milling the upper string, some of the iron had fallen on top of the rope socket, also that the prongs of the grab had broken off and lodged alongside the rope socket. The iron on top of the rope socket was milled off and a hold of the tools taken, but they could not be jarred out.

It was then decided to ream the hole to 8¼ inches diameter. Accordingly, the hole was reamed from 2,845 to 2,970 feet at which point the pin was "jumped" off the bit. Not having sufficient room to get over the bit to fish it out, it was decided to sidetrack with rotary tools. With the intention of drilling new hole entirely from this point on and sidetracking bit, tools, and bailer, a string of 4-inch rotary drill pipe was run with fishtail bit and also with a diamond point. However, the rotary tools could not get lower than 2,905 feet. As a last resort a whipstock was run with an anchor to set it up in the shale. An anchor of 4-inch line pipe was used on the whipstock setting the bottom at 2,905 feet and the top at 2,805 feet. This was cemented and allowed to set ten days. No trouble was experienced in drilling by, but at about 2,970 feet, the drill was found to be rotating in the old hole on top of the 8¼-inch bit, which was lost at this depth. Again a whipstock was set and cemented, this time on top of the bit with no anchor. After the cement had set ten days, drilling was resumed and the lost bit and tools completely sidetracked. The 6⅝ was finally landed and cemented at approximately 3,200 feet and the well successfully completed at about 3,015 feet for a daily initial production of 1,500 barrels.

All this trouble was caused by a crooked cable tool hole that had never been tested for vertical deviation. The well being in wildcat territory, the company was anxious to obtain all information possible at this location and felt justified in going to considerable trouble and expense to get it.

* Asst. Division Manager The Texas Company, Tulsa.

Missouri-Kansas Pipe Line Co. Shows Large Distribution

STOCKHOLDERS of the Missouri-Kansas Pipe Line Company have received a report on natural gas sales by the company during the month of October, showing a distribution of 400,000,000 cubic feet during the month.

This is a record for the organization and a 200 per cent increase over the same month in 1928, when sales totaled 118,747,000 cubic feet. The American Pipe Line Company, a subsidiary of Cities Service, was the largest user of Missouri-Kansas natural gas in October. This organization received 185,000,000 cubic feet from the Missouri-Kansas for the line to supply Kansas City.

Safety and Lower Operating Costs Demand . . . .

SAFE THREADS

THE Tenth Annual Convention of the International Petroleum Institute has brought out additional facts as to the importance of constant co-operation towards standardization in every branch of the Industry.

Standardization means SAFETY *and* ECONOMY

PIPE threading for drilling or any other purpose is just as important and should have as serious consideration as the casing used for your respective operations.

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The Taubman Supply Corporation joins in wishing you the Season's Greetings

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Unique System of Supplying Water to Drilling Wells

TO solve a perplexing boiler water supply problem in the Oklahoma City Field, The Indian Territory Illuminating Oil Company constructed an elaborate pumping and piping system that is delivering anywhere between 165,000 and 180,000 barrels of water daily. With the construction of this system, the producing company, with its widespread activities in the field, eliminated the drilling of a large number of shallow and light producing water wells and the building of a network of water lines to the Canadian river.

The water is pumped from the river through a central system and is treated for hardness and the mud settled out. The system supplies water for the drilling wells which are completed around 6,000 to 6,500 feet, requiring four 125-horse power, 250-pound pressure, or three 125-horse power, 300-pound pressure boilers for the pumps and engine and boiler water for the steam plants scattered over the field. Such a system requires around 30 miles of main line pipe and a full 24-hour daily operation of the main line station and its booster plant.

The main pump station and treating plant are located on a bank of the Canadian river, approximately three miles distant from the booster station in the field. The main system leaves the station with three 8-inch lines and one 6-inch line and the mains around the field are built with 6-inch pipe.

At Rouner station, nine motor-driven turbines pull the water from the river into the battery of eight 1,600-barrel wood tanks where the water is treated. The turbine pump house was built over the shore water edge of the river on steel columns set in concrete and above the flood stage of the river. Concrete-walled inlet sumps were built for the turbine suction lines, the deepest of which is eight feet below the surface.

To protect the suction lines from being choked with leaves, fish and rubbish, screens have been installed. Some of the inlet sumps were not deep enough to care for the added load on the station when field conditions required more water and, to obtain increased volume, swing lines were extended further out from the shore. Whenever the protecting screens on the lines become choked, the pumps are shut down and water permitted to flow back through the suction lines. This, with the force of the current, cleans the screens in a few minutes.

The turbine station is built with sheet metal as are the rest of the station buildings, but the turbine house has a hinged roof. Whenever it is necessary to pull the suction lines, the roof is opened and the lines pulled through the roof with a hand-operated windlass. The windlass also is used to move the swing suction lines.

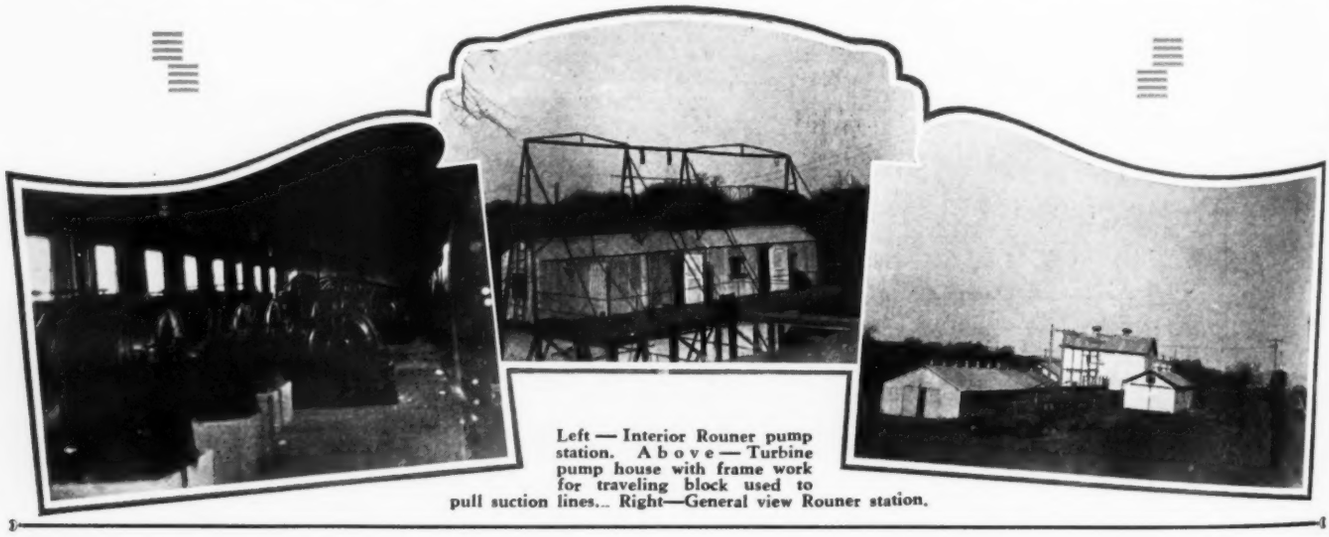
Water pumped by the turbines is delivered into a receiving manifold through five 6-inch and four 8-inch lines. From the manifold it flows through a Venturi connection and into a 15½-inch header insulated to the receiving tanks on the treating battery. A solution of lime and sodium aluminate is used to treat the water and is mixed with the stream in the large header. Around 600 pounds of lime and 80 gallons of sodium aluminate are used daily in the treating process. When the water reaches the last tank, most of the mud has been settled out and satisfactory boiler water is delivered into the main lines.

The treating tanks are built in two rows, side by side, with the header going down the center and over them. The water flow is divided and an equal volume flowed into the two receiving tanks on the end. When these two tanks fill, they flow into the next two, and so on down the line until the water reaches the last two tanks.

Sometimes the water flowing into the receiving tanks does not pass rapidly enough into the other tanks. In this event, the relief valves on the header are opened and the excess is flowed approximately equally into the remaining six tanks until the flow is regulated.

Pumps in the main line station pick up their load from the last two tanks in the battery and deliver it to the centrifugal booster station three miles away. For the past month the combination pumps at Rouner station have been working at capacity. This station is equipped with six centrifugal pumps and four plunger pumps of varying capacities. They deliver the water into the mains at 380 pounds pressure and it arrives at the booster plant at around 12 pounds pressure.

The booster plant has a capacity for 165,000 barrels of



Left — Interior Rouner pump station. Above — Turbine pump house with frame work for traveling block used to pull suction lines... Right—General view Rouner station.

water daily. The excess of 165,000 barrels or more pumped at Rouner station is accounted for in the water consumed by drilling wells and steam plants between the main and booster stations. The water from Rouner station is delivered into a 5,500-barrel working tank at the booster plant which floats on the line. Water is delivered into the mains out of the booster plant at 275 pounds pressure, which is sufficient to drive the load over the remainder of the system.

When the system was first started it was built with screw couplings. Numerous breaks in the line since then, because of contraction and expansion, have been responsible for the practice of building all new lines with suitable couplings. In every 250 feet of new line a coupling has been put in to eliminate the trouble described.

The main lines in the field for drilling wells are made with 6-inch pipe. The line is laid around each section with a 6-inch running down the middle of the section to steady the pressure. Gates are located at the corner of each section and 4-inch lateral lines branch off the 6-inch to each location for a well or to the steam plants.

Part of the load is relieved by six water wells drilled on the discovery lease, which are flowed by gas. The combined output of these wells is around 1,800 barrels daily. The gas is put in between the tubing and casing of the wells, which are between 500 and 600 feet deep. The well is flowed into a shop-made two-by-six-foot separator, the gas blowing off into the air and the water flowing to a storage tank. It is later pumped into the line to the low points. The separator is raised in the air high enough to permit the water to flow by gravity to the storage tank.

At the present time there are around 100 drilling wells on the water line and each well, on an average, uses in excess of 1,500 barrels of water daily. In isolated instances a steam condenser has been used on drilling wells to save some of the water, with astounding results. Engineers running a few tests in the field estimate that in the neighborhood of 65 per cent of the daily water supply could be cut down by the use of condensers and proper installation of boilers so as to reduce waste to a minimum.

Engineers Have Homecoming Meeting

SATURDAY'S November 23d luncheon of the Tulsa chapter of the American Association of Engineers held in the Chamber of Commerce dining rooms was in the nature of a "homecoming day."

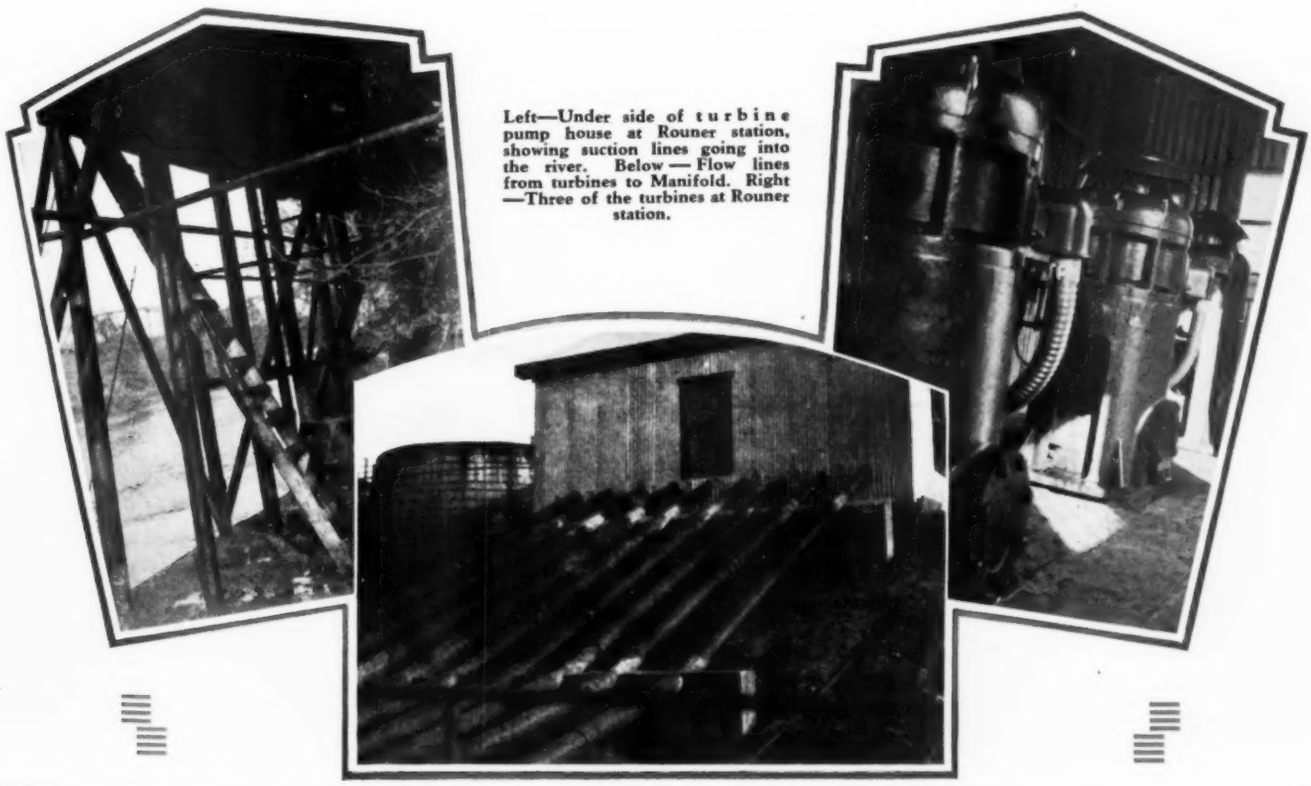
The roll call was answered by some forty engineers by giving name, place of nativity, with present business and location in Tulsa.

This rather unique roll call revealed the fact that Tulsa has drawn analytic minds from Pennsylvania, Ohio, Indiana, Virginia, Tennessee, Iowa, Kansas, Missouri, Arkansas, Texas, Colorado and California, among the states, and from Germany and Austria among the nations, and with but one native Oklahoman among those present. The phases of engineering practice represented by the members present were manifold, consisting of civils, mechanicals, electricals, architectural and chemical engineers, specializing in city and county engineering, petroleum production, refining and valuation engineering, surveying, drainage and erosion engineering, public utility engineering, gas, electric and telephone engineers, structural and architectural engineering. Many of the engineers present are closely identified with the upbuilding of Tulsa and Oklahoma.

Burning Gas Well Snuffed Out With Live Steam

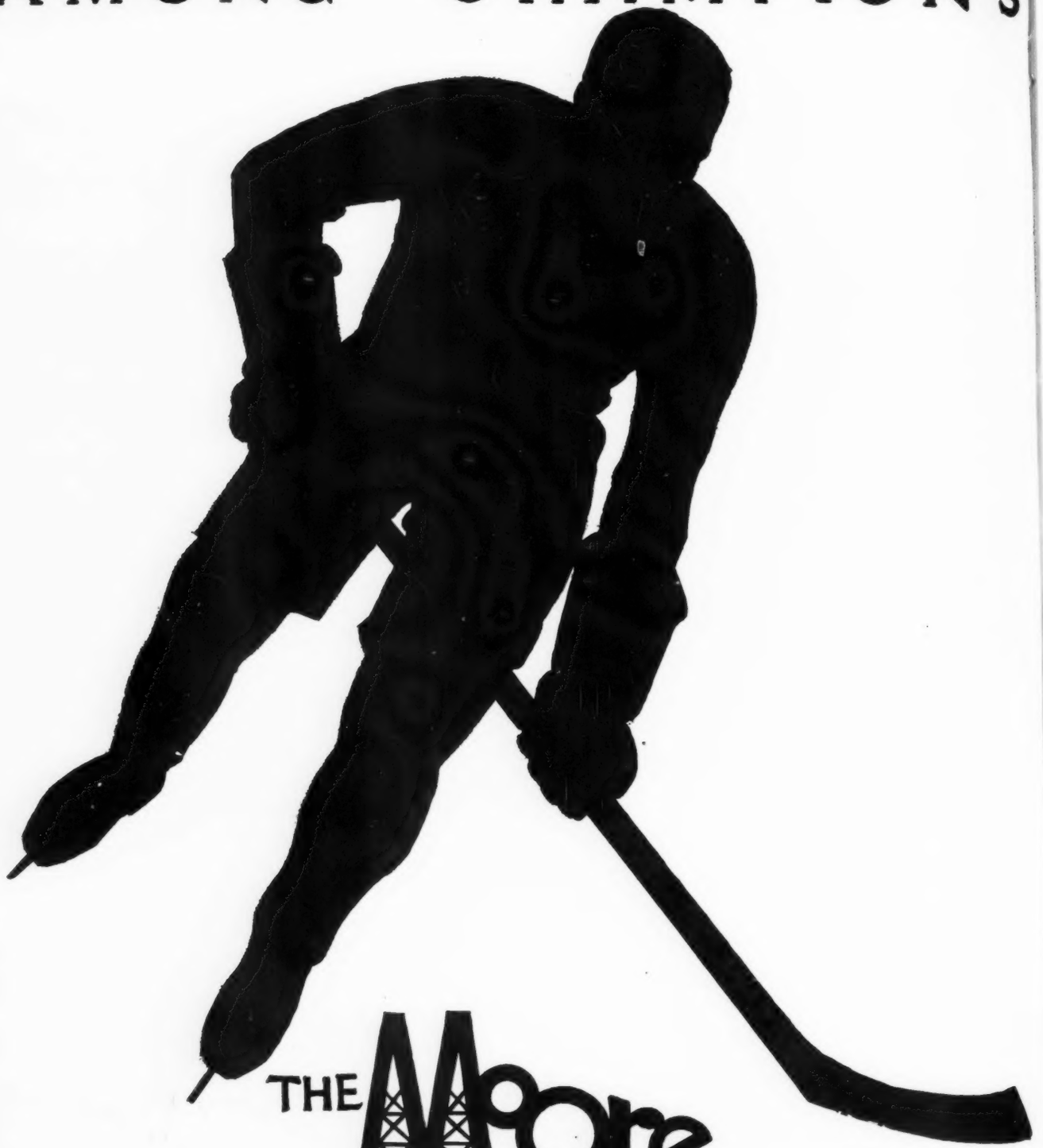
A ROARING torch burning some 40,000,000 cubic feet of natural gas a day was created when the Red Bank Oil Company's well was ignited by friction recently.

Lines were quickly run and live steam directed upon the fire, but it resisted every effort to smother it. It was finally snuffed out by the steam, just before plans for shooting it out with nitroglycerine were completed. This well is now under complete control and is said to have the largest flow in the southwestern part of Oklahoma.



Left—Under side of turbine pump house at Rouner station, showing suction lines going into the river. Below — Flow lines from turbines to Manifold. Right —Three of the turbines at Rouner station.

AMONG CHAMPIONS



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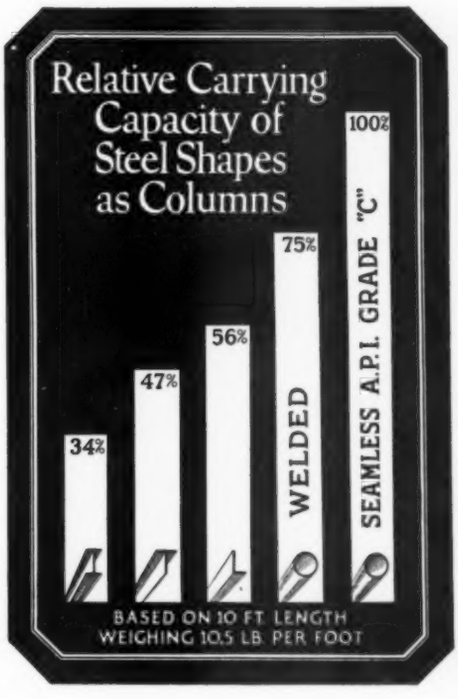

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Pipe Still Distillation Effective in

Making Lubricating Stocks

By C. M. RIDGWAY, *Smith Engineering Co.*

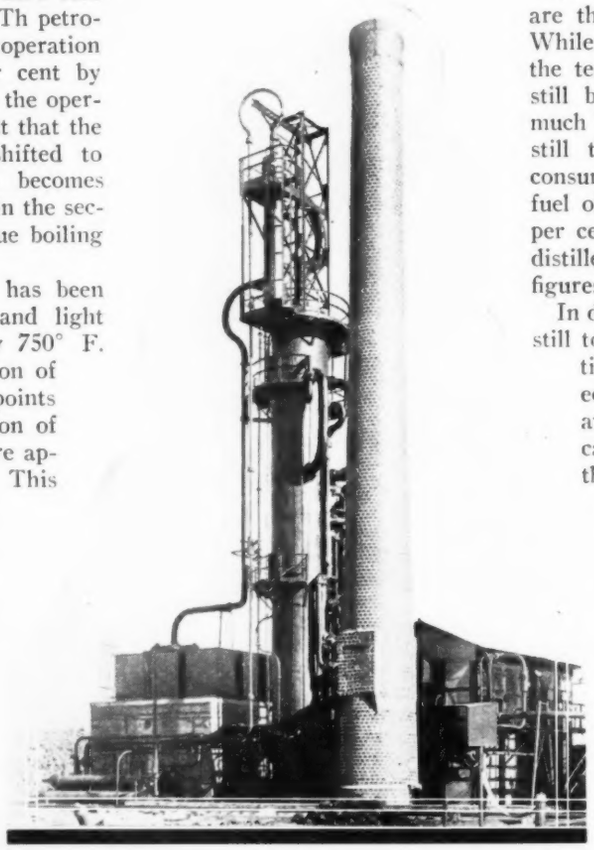
IT is an established fact that the modern pipe still is the most efficient unit for distilling crude oil and many of the more progressive refiners have adopted or are about to adopt it for the primary distillation of their crude and the production of light oils. However, at the present time comparatively few refiners are equipped with pipe stills for the distillation of lubricating stocks such as dewaxed long residuum or bright stock solution and pressed distillate. A few of the refiners have recognized that such units are a very attractive investment as their potential earnings per dollar invested is probably greater that that of nearly any other single piece of equipment in their plant. This is due to the fact that the amount of fuel and steam saved per barrel of oil processed is greater than in the case of the crude unit because in the batch distillation of lubricating stocks enormous quantities of steam must be used to protect the color and the time from charge to still off is much longer. Furthermore the stock being distilled costs more per barrel than the crude and the increased yield due to efficient fractionation and the prevention of cracking represents a larger saving. In discussing the distillation of dewaxed lubricating stock solution, the application of the pipe still to the distillation of long residuum solution has been selected.

Normally the long residuum solution as it is delivered to the centrifuge is composed of 65 per cent naphtha and 35 per cent of stock (approximately 75 viscosity at 210° F.), however, if it is desired to make a zero cold test oil the ratio becomes 70:30. Th petrolatum loss during the dewaxing operation amounts to approximately 10 per cent by volume of the net stock charged to the operation. Because of this and the fact that the Naphtha-Petrolatum ratio has shifted to 40:60, the Naphtha-Stock ratio becomes 68:32 for the first case and 74:26 in the second case. Figure 1 shows the true boiling point curve of such a solution.

For this particular solution it has been demonstrated that the naphtha and light ends boiling up to approximately 750° F. must be removed for the production of 85 vis. at 210° F. stock. The end points of the cuts made for the production of 125 vis. and 145 vis. at 210° F. are approximately 810° F. and 850° F. This means that if batch or semi-continuous methods of reducing are used, the effective still temperature is at least as high as the end point of the material which must be removed. Temperatures of this order of course are not permissible on account of the loss in color and viscosity due to cracking, consequently large amounts of steam must be used. Furthermore, where a large volume of oil is being heated the rate of heating must be low to prevent local overheating of the oil on the bottom of the still. This in turn means that the whole mass of oil is held at a relatively high temperature for a long period of time. The method of semi-continuous operation as practiced in some of the Mid-Continent refineries, is given below:

The solution is charged into the still at the rate of 75 to 100 barrels an hour and is fired as soon as the still bottom is well covered. By the time the still contains 300 barrels the temperature is at 300-310° F., enough steam being admitted to give complete agitation and remove the naphtha. Charging is continued until about 1,250 barrels of solution have been charged, the still temperature being maintained at 300 to 310° F. The charging and naphtha removal require about 16 hours. After the naphtha has been removed approximately 300 to 350 barrels of stock remain in the still and is reduced to the desired viscosity by fire and steam. The temperature is increased at the rate of ten degrees an hour to that required by the character of the stock desired. The total time required for naphtha removal and reducing is 35 to 40 hours. Table I gives the typical conditions and yields for the production of three stocks.

The neutral cut is allowed to accumulate for a period of time and is then rerun as the original distillation does not give the required viscosity—flash relationship. This redistillation results in a loss of about 10 to 20 per cent as Gas Oil.



The temperatures given in Table I are those of the oil in the still body. While it is difficult to exactly measure the temperature of the oil film on the still bottom, it is without doubt very much higher than that recorded by the still thermocouple. The average fuel consumption of such a still expressed as fuel oil will not be less than 4½ to 6 per cent of the total volume of the oil distilled and frequently exceeds these figures.

In discussing the application of a pipe still to the distillation of dewaxed solution the use of a well-designed still equipped with an efficient fractionating column is presupposed. Great care must be taken in the design of the still to keep the time at high temperatures and the film rise at a minimum.

Due to the nature of flash distillation the temperature required to remove the light ends from this solution is not nearly as high as that required by batch distillation. Consequently the steam and fuel consumption will be considerably lower. A relatively small amount of oil is being heated at one time and the time at elevated temperatures is

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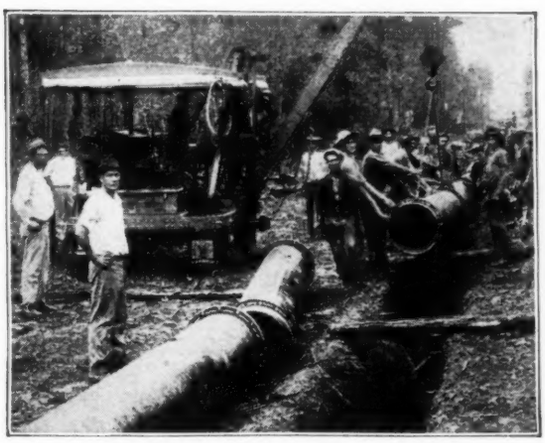

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Biturine Coatings have earned the respect and enthusiastic endorsement of pipe line operators and their engineering staffs, for Biturine has met the exacting requirements of rigid competitive tests and is today demonstrating its superiority in thousands of miles of pipe lines.

We will be glad to furnish you with records of service of Biturine coated lines upon receipt of your inquiry at any of the offices listed below.

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a matter of seconds rather than hours. Furthermore, in a properly designed still the film temperature rise is negligible. Since cracking is dependent upon time and temperature each is held at an absolute minimum, resulting in practically no loss in viscous units and a much improved color.

TABLE I.

Batch Distillation of 75:25 Dewaxed Long Residuum Stock.

Viscosity of Stock at 210°F.	Reducing Temperature	Steam Consumption Lbs. Per Bbl.	Yields Naphtha	Gas Oil	Neutral	Stock	Loss
85	540	120	72	2.5	2.5	20	3
125	570	150	72	2.5	7.0	15.5	3
145	600	170	72	2.5	9.0	13.5	3

In a pipe still installation the solution is fed continuously through the heat exchanging system to the pipe still, thus effecting a considerable saving in cooling water and fuel. After being heated to the proper temperature under closely controlled conditions, it is transferred to the fractionating tower where it is flashed in the presence of steam. Naphtha, Gas Oil, Neutral and Stock of easily controlled characteristics are simultaneously produced. Table II shows the yields resulting from the pipe still distillation of the same solution mentioned in Table I.

unit the yields would be approximately as follows: 52 per cent of 240 viscosity at 100° F. neutral and 10 per cent at 100 viscosity at 100° F. neutral. Furthermore the fuel consumption will be approximately 2 per cent of the oil charged

TABLE II.

Viscosity of Stock at 210°F.	Steam Consumption Lbs. Per Bbl.	Yields Naphtha	Gas Oil	Neutral	Stock	Loss
85	35	74.4	0.7	0.8	23.5	.6
125	35	74.4	0.7	6.8	17.5	.6
145	35	74.4	0.7	8.5	15.8	.6

and the steam requirement will be around 25 lbs. per barrel. It might be well to state at this point that the process steam used by a well-designed pipe still unit will consist largely of exhaust steam from the product and charging pumps of the unit. This will result in even a larger steam saving than has been indicated. An increase in the flash-viscosity relationship will be found and the color will also be much improved for precisely the same reasons as was outlined in the discussion of dewaxed solution, namely: good fractionation and freedom from cracking.

Some refinery engineers advocate the installation of separate units for the distillation of these two typical lubricating

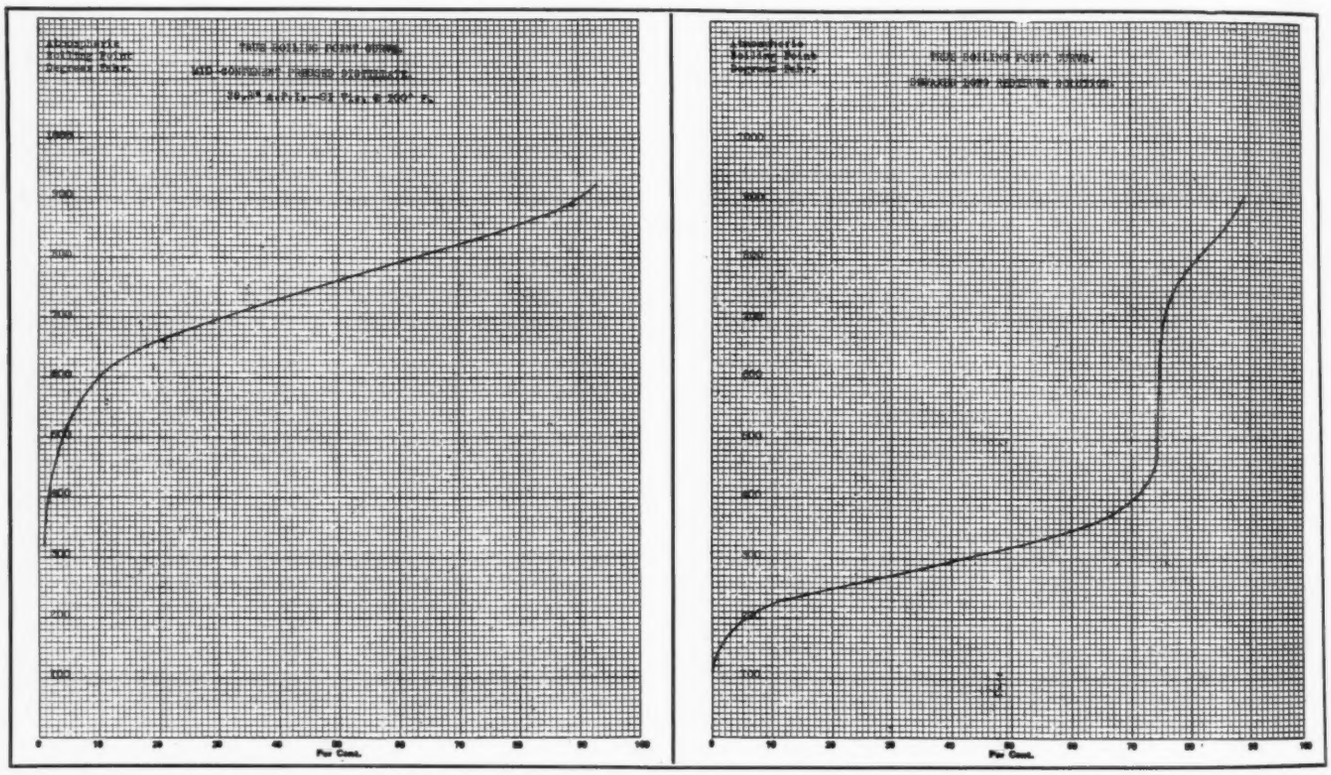


Figure II shows the true boiling point curve of a typical Mid-Continent pressed distillate. To produce a 250 vis. at 100° F. neutral the light ends boiling up to 790° F. must be removed. As was indicated in the discussion of dewaxed solution this necessitates the use of large amounts of steam to keep the still temperature within reason and results in long time exposure to relatively high temperatures where the batch method of reduction is being used.

In batch distillation about 35 to 40 per cent of 240 viscosity at 100° F. neutral will be recovered by the first distillation, requiring in some cases as much as 80 to 100 lbs. of steam per barrel of pressed distillate and 6 per cent fuel expressed as a percentage of the total volume distilled. The tops from this distillation are reduced a second time and a recovery of 9 to 12 per cent (based on the original pressed distillate) of 150 viscosity at 100° F. neutral is realized at the expense of course, of considerably more steam and fuel.

If the same pressed distillate is reduced in a pipe still stocks. From a theoretical standpoint this is perfectly correct and it is recommended for refineries where large amounts of each material are being processed. However, in plants where the total amount of the two stocks being distilled is about 1,000 to 2,000 barrels per day, it would make the installation cost rather high because it so happens that the difference in cost between a 1,000-barrel unit and a 2,000-barrel unit is considerably less than the capacity ratio. If care is taken in the designing of a single unit, it can be used for distilling both stocks without the slightest difficulty.

The advantages of pipe still distillation of lubricating stocks may be briefly summarized as follows:

(1) Decreased fuel and steam consumption.
(2) Increased yields of valuable lubricating stocks.
(3) Decreased distillation loss.
(4) Better color.
(5) Increased flash for a given viscosity.
(6) Eliminates the necessity for rerunning.

Mud Fluid Pressures and Their Relation to

Straight Hole Drilling*

By J. T. HAYWARD,
Consulting Engineer, Tulsa, Oklahoma

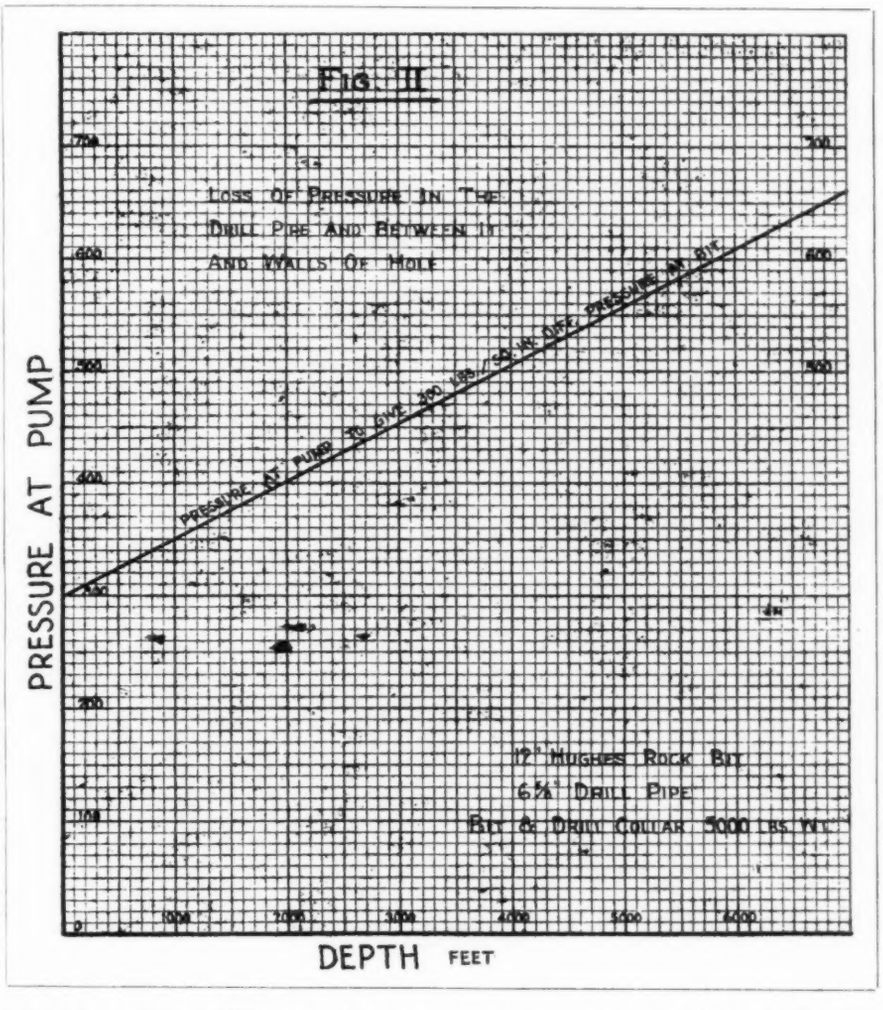
GREAT progress has been made during the last few years in the technique of drilling straight holes and detecting crookedness when it occurs. Nevertheless a lot remains to be done and the tendency of the drill to deviate from the vertical requires constant vigilance, and often results in carrying weights on the bit considerably less than those that would be used if maximum footage was the only concern.

It is herein submitted that the mud fluid pressures in the bottom joints of the drill pipe play an important part in keeping the hole straight and to a certain extent govern the weight that can be safely carried on the bit during drilling. The fluid pressure referred to here is, of course, the difference between the pressure in the drill pipe and that outside at the same level. This differential pressure it is suggested has a stiffening effect on the pipe that may prove to be of considerable importance.

The ratio of the diameter of a string of 6-inch drill pipe to its length in a 5,000-foot hole is as 1 to 10,000. A column of such a diameter to length ratio would tend to buckle under compression even of the lightest nature, and that a straight hole should ever be drilled with such a drill would, at first sight, appear to be surprising. It is suggested that it would in actual practice be very difficult and that the hole would be liable to go crooked whenever there was any compression in the bottom joints.

The cross sectional area of 6⅝-inch drill pipe, minus the water courses in the bit is roughly *27* square inches. Considering the case of an 11-inch bit, drill collar, etc., and a mud fluid pressure of 290 pounds per square inch at the bit acting on the above-mentioned cross sectional area, there would be tension of 10,000 pounds in the last joint of the drill pipe, when the bit was just off bottom. A pressure of 10,000 pounds could therefore be put upon the bit without putting the drill pipe in compression.

There did not appear to be much reliable data available regarding the differential pressure at the bit. Pressure records at the pump are obtainable but the friction losses in and outside the drill pipe were not known. The differential pressure of 290 pounds per square inch assumed in the last paragraph was calculated from the pump speeds observed at a number of wells and the known diameter of the water courses in the bit.



Recently the writer carried out a number of tests on a well belonging to one of the major operating companies in the Mid-Continent field and which were designed to determine friction losses in the drill pipe and the actual differential pressure at the bit. The method adopted to obtain these pressures was as follows: The hole was filled up and the bit, drill collar, and a stand of pipe run into it. The slush pump was then started and the fluid pressures corresponding to the various pump rates noted. Neglecting the losses in the hose and drill stem which are in any case small in proportion, these pressures are those required to force the liquid at the various rates through the water courses in the bit, and when the bit is near bottom or drilling the differential fluid pressure across it should not differ much from that found in the above manner for the same rate of circulation. The same procedure was followed at 1500, 3000, and 3830 feet as a check and to obtain the frictional losses in the drill pipe and the hole. The graph Fig. I depicts the differential pressure at the bit at various pump speeds. The pump (14½" x 7½" x 18") was in good condition and the bit was a 12-inch Hughes Rock Bit. This graph can of course be used in any case with a bit with similar water courses and gives the differential pressure at the bit independently of the depth,

* Presented before the American Petroleum Institute, at Chicago, Ill., Dec., 1929.

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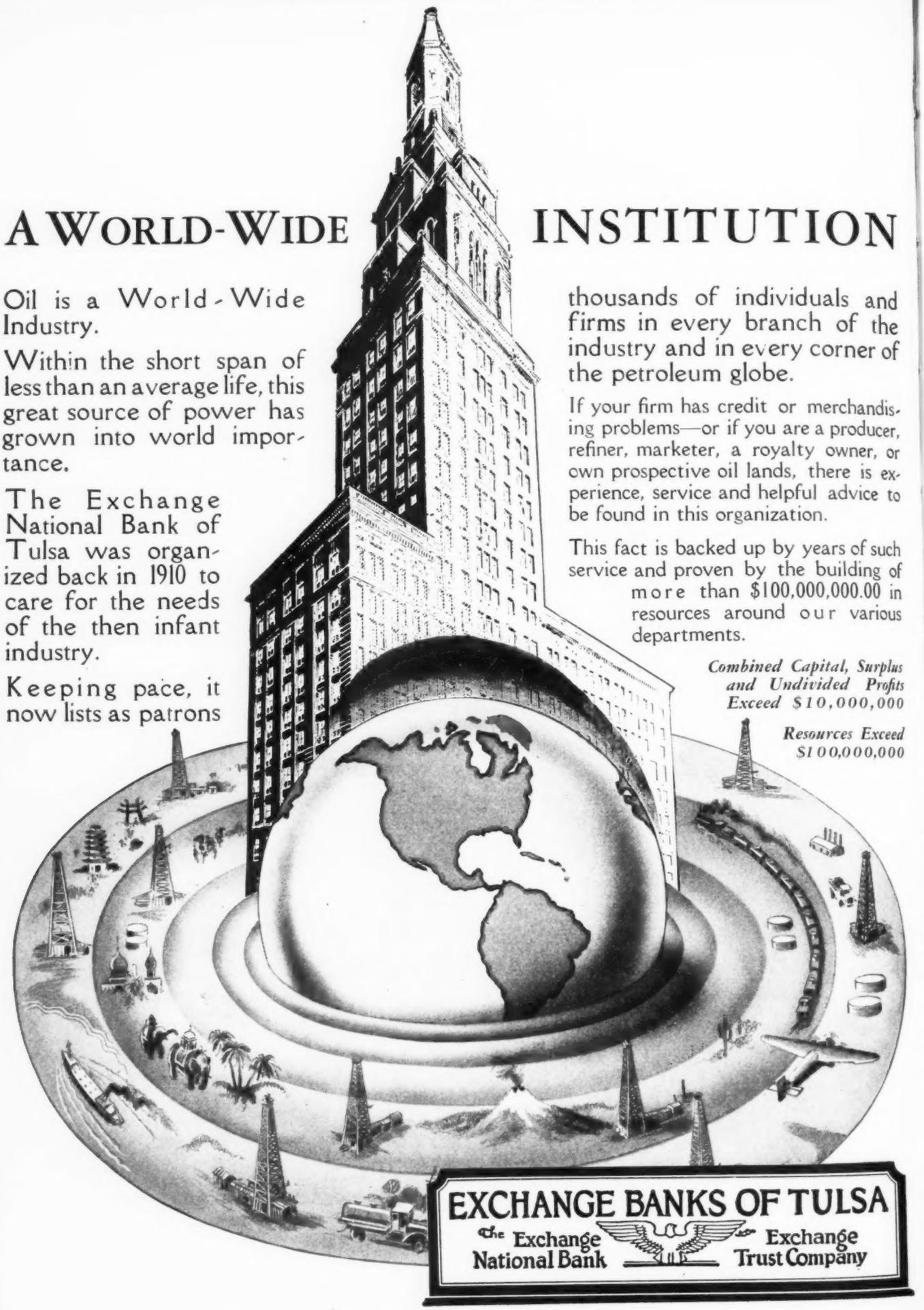

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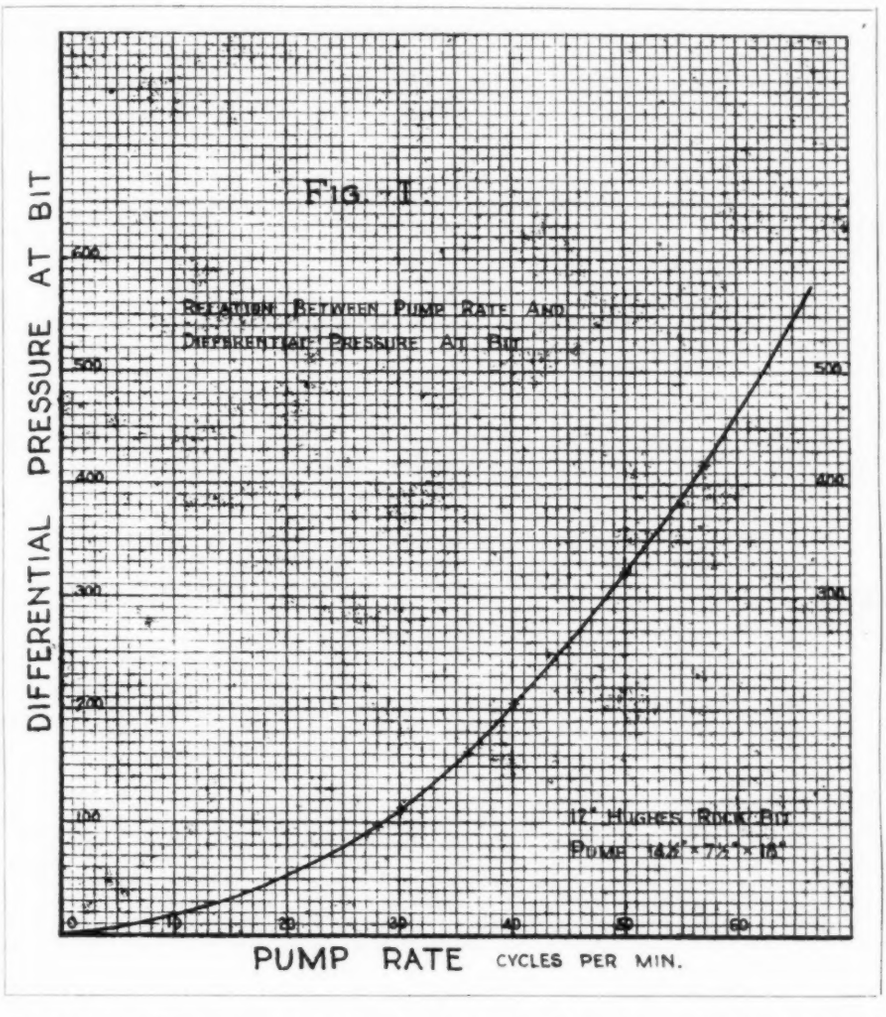
the drill pipe or the size of the hole. The characteristics of the mud fluid would affect the figures to some extent and the actual weight of the mud used was not obtained but it was fairly thin.

The graph Fig. II depicts the pressure that would have to be put up by the pump in order to maintain 300 pounds per square inch differential pressure at the bit and which would require a pump rate of 48½ complete cycles per minute. The graph refers to the same bit and pump dimensions as those previously given and the drill pipe was A. P. I. Seamless Interior Upset Pipe, I. D. 5.96 with a nominal weight of 25.20 pounds per foot and with a tool joint on every length. The hole was 12 inches. The weight of the bit and drill collar at this well was about 5,000 pounds submerged, and with the above pump rate and differential pressure, 13,000 pounds weight could be put on the bit without putting any compression in the bottom joint of drill pipe. In the same manner at 4,000 feet a pressure at the pump of 507 pounds per square inch would be required and 560 pounds per square inch at 5,000 feet.

Pump pressures in the Oklahoma City field range during drilling from 500 to 900 pounds per square inch at the pump and it appears, therefore, that it is quite practical to drill with 6⅝-inch pipe to 5,500 feet while maintaining some tension in the last joint of pipe and still putting a reasonable weight on the bit.

The writer has not found any records correlating the straightness of the hole with the weight on the bit and the differential fluid pressure at the bottom. The present is a plea for the inclusion of the differential fluid pressures with the other data collected during investigations on the straight-hole question.

Assuming the correctness of the hypothesis outlined earlier, namely, that it is possible and desirable to drill without putting compression in the lower end of the column of drill pipe, a number of modifications in the equipment suggest themselves. It would, for instance, be important to keep the fluid friction in the drill pipe to a minimum by making the holes through the tool joints as large as practical, and possibly also stream line them so as to lose as little of the pump pressure as possible between the surface and the bit. The usual drill collars have an internal diameter smaller than that of the pipe and cause a part of the hydraulic pressure to be applied on a cross section some distance above the bit. For straight hole drilling it would appear desirable to apply the pressure at the lowest practical point, for which purpose a short section in the bit itself, or in the lower end of the drill collar, might be recessed out to a diameter as nearly equal to that of the inside of the pipe as possible. Again, the larger the internal diameter of the lower 200 or 300 feet of drill pipe the greater the weight that could be put on the bit with any given differential fluid pressure without putting the drill pipe into compression. This condition would point to large diameter pipe with flush jointed internal couplings for the bottom stands. The outside diameter of the standard 6⅝-inch couplings is 7¾ inches, and without exceeding this figure it should be practical with flush jointed pipe to attain an internal diameter of 7 inches. With 200 feet of this pipe the differential fluid pressure of 300 pounds per square inch and 2,200 pounds due to the weight of the bit and drill collar it would be possible to put a weight of 13,000 pounds on the bit without putting any compression in the drill pipe.



While high differential fluid pressures may, for the reasons outlined above, prove to be desirable in the lower end of a string of drill pipe, they are certainly detrimental in the upper end. The dead weight loads for instance on a 5,000-ft. string of 6-inch pipe may be increased by more than 30% by the mud fluid pressure put up by the pump. Increasing depths will probably direct efforts to decreasing the additional tension in the pipe joints due to the fluid pressure and enable greater depths to be attained without increasing the total load on the joints but at the same time maintaining the straight hole drilling effect of high differential fluid pressures at the bottom.

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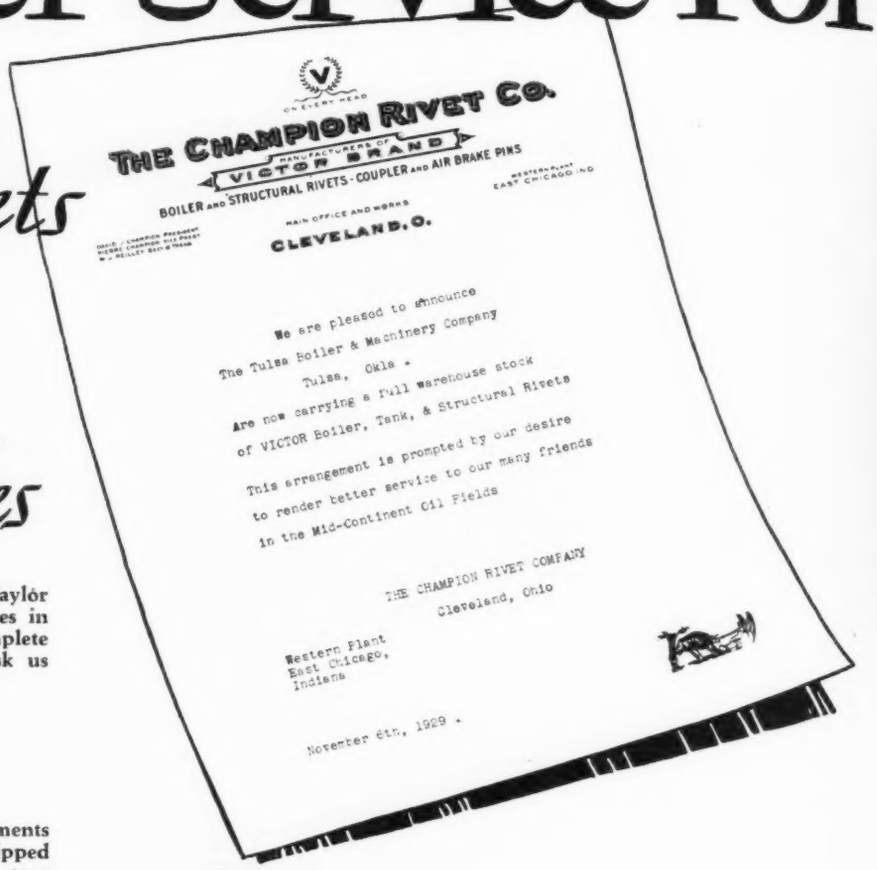
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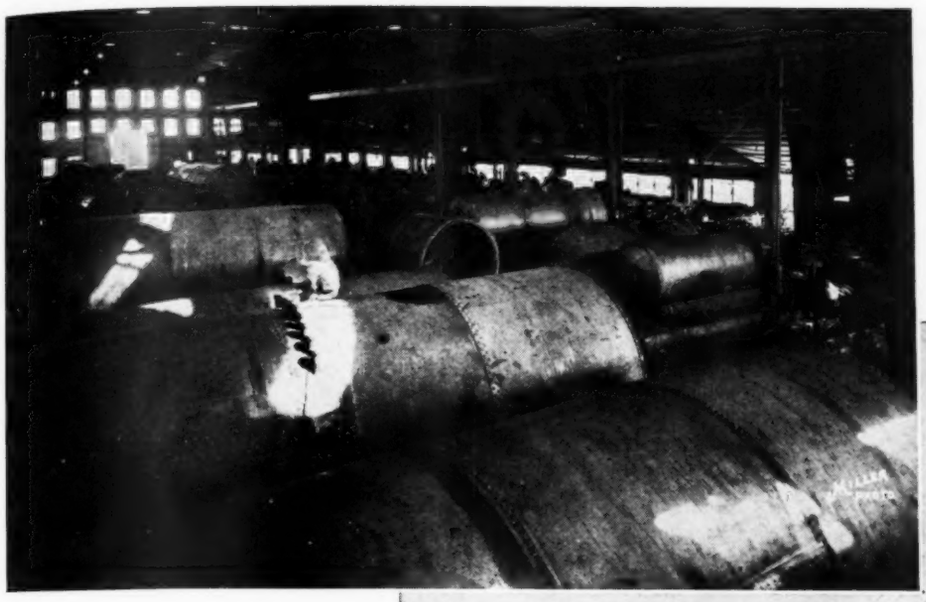

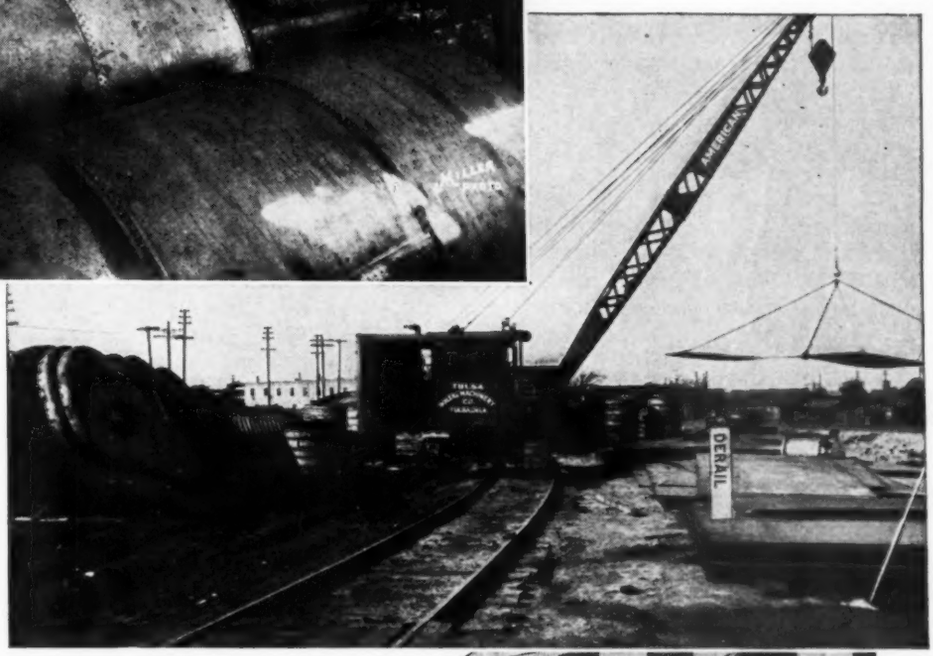

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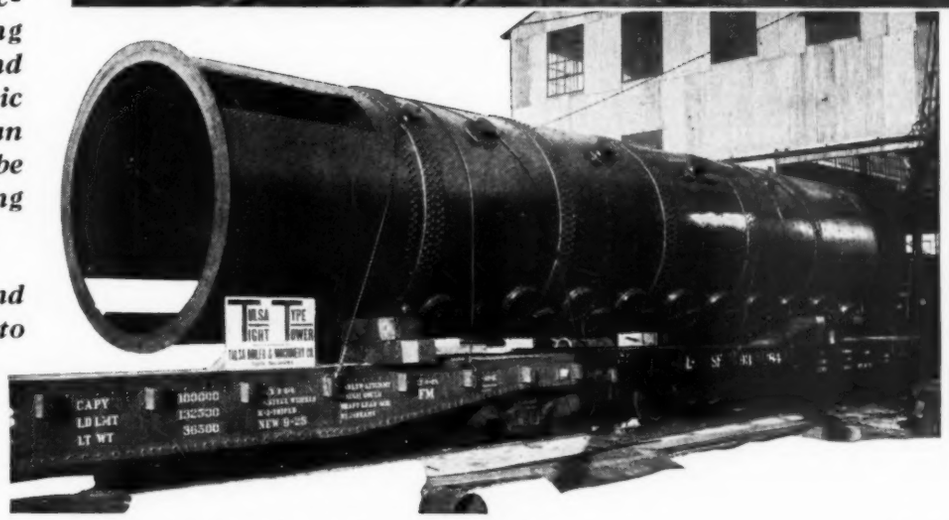

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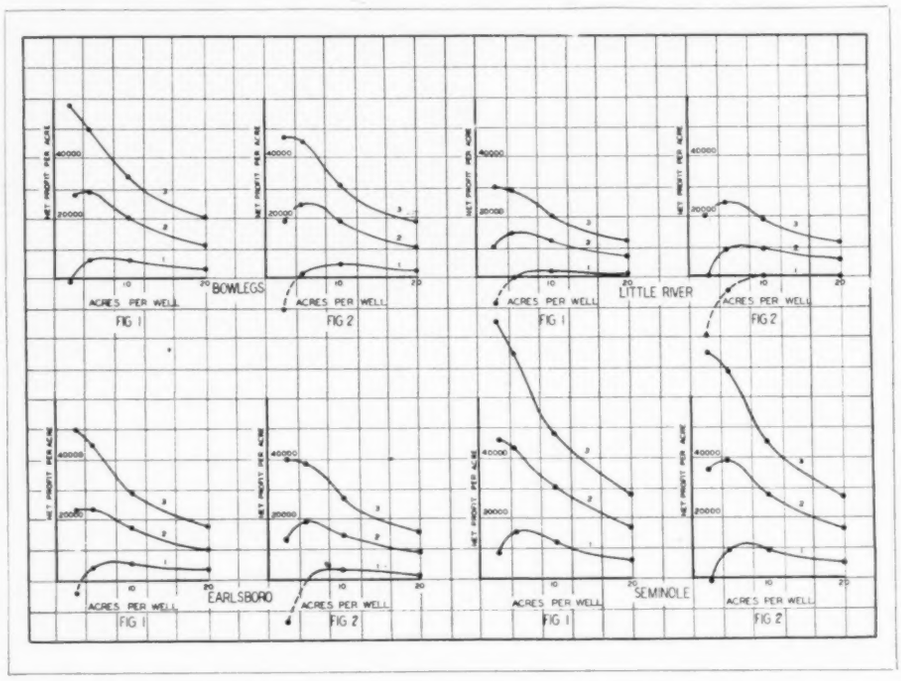
A Theory *of* Well Spacing†

By W. P. HASEMAN,*
Oklahoma City, Okla.

THE well method of producing oil and gas is universally used in the development and operation of oil and gas properties. It consists essentially in the spacing of a number of wells on a given tract, and in drilling and operating them in accordance with established practices. The method is based on a fundamental energy principle. This principle governs the state and the change of state of fluids or fluid mixtures confined under pressure within a porous and permeable reservoir in such a way as to direct a flow from the reservoir into and out of a drilled well with a reduction of potential energy.

The application of the well method of producing oil has given data which prove that the total yield of oil from a reservoir through wells is, in general, only a small fractional part of the total oil that is contained in the reservoir. It is generally recognized that a spacing of one well to each 160-acre tract of any good oil pool is too wide. However, one well to this 160-acre tract will yield a large quantity of oil and in time will dissipate most, if not all, of the potential energy that was originally stored and retained in the fluids by pressure. Two wells spaced and drilled on this 160-acre tract would yield approximately twice the quantity of oil, while four wells would yield approximately four times the oil.

A well spacing is soon reached, with the addition of wells to this 160-acre tract, in which the drainage interference of offset wells will materially affect the yield of oil per well. The increased yield of oil, therefore, is not directly proportional to the added number of wells but the increased costs of development are directly proportional to the added number of wells. It is evident then that while an added number of wells to this 160-acre tract yields an increased quantity of oil, there is an economic limit to the number of wells to be added. The yield of oil and the costs of development and operation are of such a nature, and are so related, that the net profit to be yielded from this 160-acre tract will increase to a maximum at some critical number of wells.[1]



A spacing of wells on a given tract which efficiently utilizes the natural potential energy in the fluids in the yield of oil, is generally too wide for the efficient utilization of the artificial energy of repressuring. Added wells are essential, therefore, in most repressuring operations. These added wells, however, should be drilled in the early development of the tract and operated so as to secure an added efficiency in the utilization of the natural potential energy in the fluids. The early addition of these wells up to a certain limit is more effective in securing an increased economical yield of oil than is the repressuring operation.

The spacing of wells is truly a scientific problem. It has been formulated and a solution has been reported in a recent paper.[2] The principles which control well spacing and which are essential to a formulation of the problem will be outlined and briefly discussed.

The yield of oil from a well is known to be affected by many and varied factors.[3] This fact precludes the development of a practical well spacing formula which includes as many constants as there are factors. It is possible and of interest to classify and list these factors in groups and to analyze and formulate the well-spacing problem in terms of group factors. As a basis for this discussion the factors will be listed in two groups:

Group 1 — Fixed factors

Group 2 — Variable factors

Most of the fixed group factors define the conditions or characteristics of the reservoir stratum and the confined fluids which affect the yield of oil. The fixed group factors affect the potential oil of a pool that can be yielded by wells and determine whether or not an oil pool will be commercially profitable for any spacing of wells whatsoever. Among these factors are porosity, sand texture, cementation, specific

* Consulting Engineer.

† Presented before the Fall meeting of the A. I. M. E.

[1] W. P. Haseman: Profits and Proper Spacing of Wells. Oil and Gas Jnl. (Oct. 18, 1928) **27**, No. 22, 53.

[2] W. P. Haseman: A Formula Method for Well Spacing and Rate of Production. Natl. Petr. News (May 8, 1929).

[3] *Idem.*

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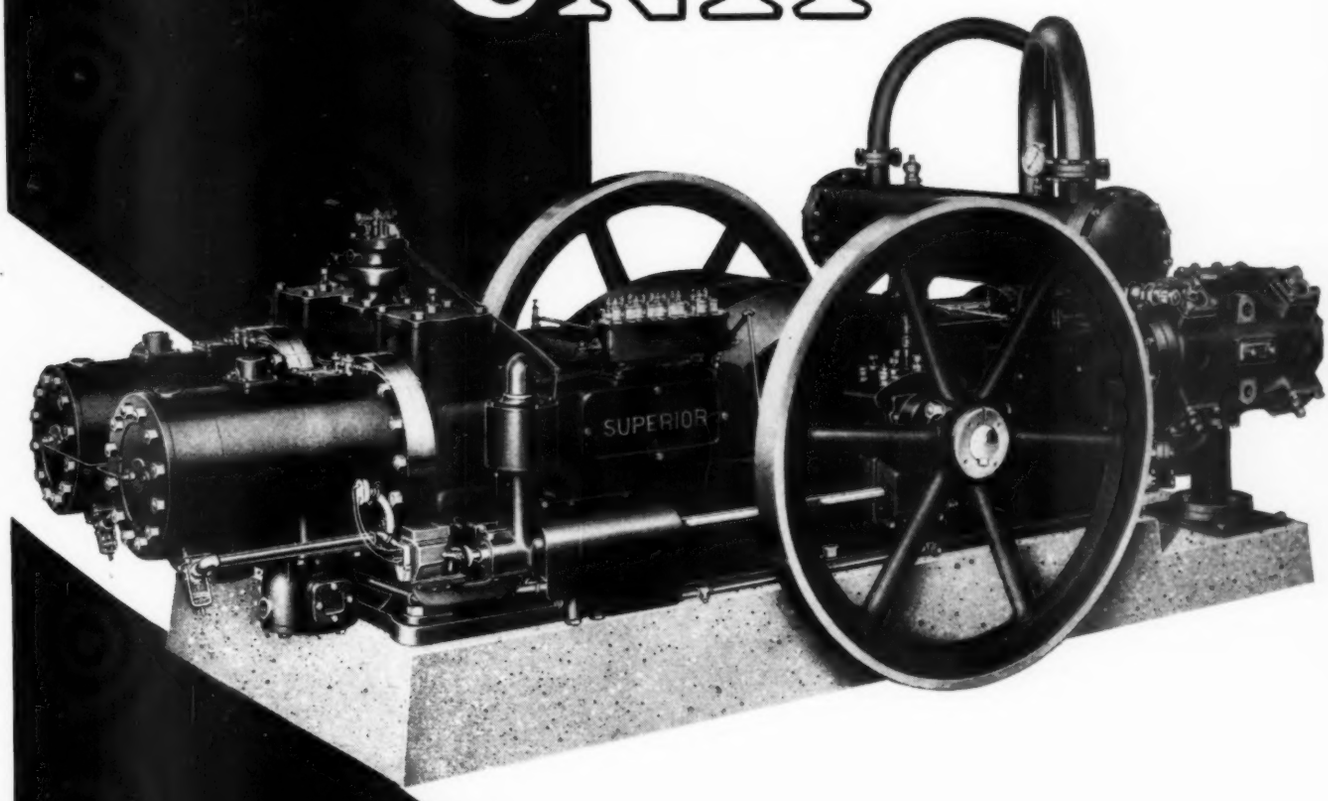

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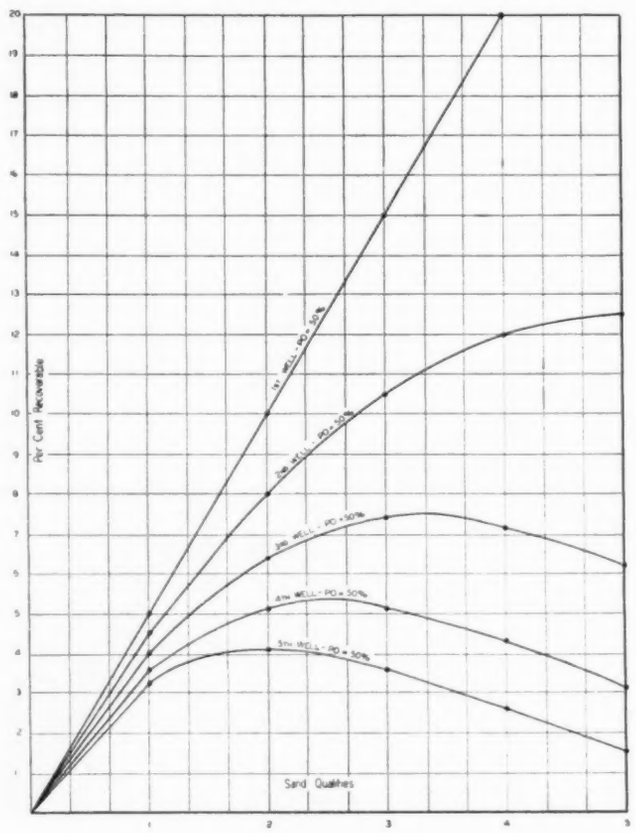
gravity of oil, viscosity of oil, natural gas-oil ratio, thickness of pay stratum, saturation of pay stratum, etc. They affect the yield of the oil from a well in a more or less uniform manner for the various spacings of wells. The magnitudes and trends, if any, of their influences on the yield of oil are considered to be fixed and not materially altered, at least, by any spacing of wells such as would be used in the commercial operation of a given tract in an oil pool. The variable group factors are largely controllable factors and can be fixed at will. Among these factors are the spacing of wells, the timing of completion of offset wells, the depth of penetration of the pay stratum, the method of control of producing wells, etc.

It follows then, in case the operations are carried out on a given tract under such conditions that the spacing of wells is the only variable factor, that the yield of oil from a well or the tract can be expressed in a formula with one constant.[4] This constant is termed the spacing constant and its value is to be determined by field data.

The Derivation of Formula

The production of oil by the well method is a phenomenon that is controlled by fundamental principles. These principles govern many natural phenomena such as monomolecular and radioactive changes. In picturing this phenomenon of producing oil, each producing unit, which consists of one well, the reservoir stratum and the confined fluids within the drainage distance of the well, is assumed to contain a definite and measurable quantity of oil. This quantity of oil is considered to be composed of two portions, the one portion termed Active and the other Inactive.

The active oil is energized by the gas and vapors associated and retained with it under pressure. It represents the potential quantity of oil that can be yielded by drilled wells. The number and spacing of the wells to a given tract determine, largely if not wholly, the efficiency of the yield of this potential oil. The inactive oil represents the quantity of oil that is held on the material grains of which the reservoir stratum is composed, and is otherwise held by films and allied molecular phenomena. The inactive oil must be treated or acted upon by some agent such as heat, chemicals, etc., before it is transformed into active oil and yielded commercially by wells. Now let



P_o represent the total quantity of active oil under a given tract,

P_n represent the quantity of active oil that is yielded by n wells spaced to the given tract,

$P_o - P_n$ represent the quantity of active oil remaining in the reservoir and which could have been yielded by added wells spaced to the given tract.

In accord with the principles that control these changes, an added well to the tract would have yielded an added quantity of oil proportional to the quantity of active oil remaining in the reservoir under the tract. Therefore

$$\frac{d\,P_n}{dn} = \lambda\,(P_o - P_n)$$

Integrating and substituting limits,

$$P_n = P_o\,(1 - e^{-\lambda n})$$

Discussion and Application of Formula [5]

This is a spacing formula which can be applied directly to the spacing of wells on tracts in an oil pool provided the operating conditions in the pool conform to the assumed conditions in the formula. When the operating conditions deviate from the assumed conditions, it is necessary to evaluate the disturbing conditions by special knowledge and formula and to introduce an engineering safety factor into the result of the spacing formula.

This formula is most useful in the science of oil production. It gives new and needed data that check most favorably with available field data. In addition, it is the fundamental basis upon which there has been developed a practical method for the study and determination of the program of development and operation of an oil property that would give a greater yielding efficiency of oil and profit. The method is equally applicable to proved but undeveloped properties and to depleted but repressuring properties.

The formula is general and applicable equally well to sands of various producing qualities. It expresses a simple relation between ultimate oil yield and spacing of wells. It may be used for properties where one well is drilled to each ten-acre tract and yields 5, 10, 15, 20, and 25 per cent of the total oil from the reservoir. It is also applicable to cases where an infinite number of wells are drilled to teach ten-acre tract and yield 10, 20, 30, 40, 50, * * * and 100 per cent of the total oil from the reservoir. How well it fits the spacing problem is seen in Table 2 where actual field data are tabulated with computed data.

The formula when applied to a given property under the assumptions gives computed data as tabulated in Table 1. These data show, for example, that, if one well were drilled to each ten-acre tract and the ultimate oil yield by a given mode of operating the wells were ten per cent of the total oil from the reservoir, then two wells drilled simultaneously on this same tract will yield 17.991 per cent, or an added (ΔP) of 7.991 per cent for the second well.

The data given in Table 1 are shown graphically on Figs.

[4] *Idem.*

[5] Natl. Petr. News (May 8 and June 5, 1929).

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1 and 2. Fig. 1 represents the total percentage of oil yielded by drilling one, two, three, four, five, six, seven, eight, nine and ten wells to each ten-acre tract of a given property with a sand of ten per cent quality. Fig. 2 shows the added percentage of the total oil in a reservoir yielded from sands of varying qualities by additional wells.

The line for the first well defines the sand qualities for oil yields. The curves show that from the standpoint of ultimate yield alone the better the sand the more advantageous to drill additional wells to a ten-acre tract. However, from the standpoint of the economic yield of oil, the volume of oil contained in the reservoir as well as the quality of the sand must be considered.

Table 2 compares actual field data with this computation. It reveals that in the Bartlesville-Dewey District in Oklahoma if one well be drilled to each ten-acre tract yielding ten per cent of the total oil from the reservoir, then

(1) 0.66 well to each ten-acre tract actually yields 6.95 per cent as compared with 6.88 per cent computed yield.

(2) 1.42 wells to each ten-acre tract actually yield 14.08 per cent as compared with 13.62 per cent computed yield.

(3) 2.00 wells to each ten-acre tract actually yield 15.92 per cent as compared with 17.99 per cent computed yield.

(4) 3.33 wells to each ten-acre tract actually yield 22.90 per cent as compared with 26.21 per cent computed yield.

The increase of computed yield noted over the increase of actual yield as the spacing was closer is probably due largely to the fact that the wells were not completed simultaneously and operated uniformly.

TABLE 1.

COMPUTED DATA FROM APPLYING THE HASEMAN FORMULA TO A GIVEN PROPERTY.

No. Wells Per 10 Acres	Pn	ΔP	Pn	ΔP	Pn	ΔP	Pn	ΔP	Pn	ΔP
1	5.000	5.000	10.000	10.000	15.000	15.000	20.000	20.000	25.000	25.000
2	9.471	4.471	17.991	7.991	25.467	10.467	31.970	11.970	37.496	12.496
3	13.511	4.040	24.389	6.398	32.815	7.348	39.173	7.203	43.747	6.251
4	17.148	3.637	29.508	5.119	37.963	5.148	43.499	4.326	46.873	3.126
5	20.422	3.274	33.604	4.096	41.568	3.605	46.096	2.597	48.436	1.563
6	23.370	2.948	36.881	3.277	44.094	2.526	47.656	1.550	49.218	.782
7	26.025	2.655	39.504	2.623	45.863	1.769	48.592	.936	49.609	.391
8	28.414	2.389	41.602	2.098	47.102	1.239	49.155	.563	49.805	.196
9	30.566	2.152	43.280	1.678	47.974	.872	49.492	.337	49.902	.097
10	32.503	1.937	44.624	1.344	48.578	.604	49.695	.203	49.951	.049

TABLE 2*

ACTUAL FIELD DATA COMPARED WITH COMPUTED DATA FROM THE HASEMAN FORMULA

NOWATA DISTRICT (OKLAHOMA)

No. of Wells Per 10 Acres	Initial Year's Yield in Bbls.	Ultimate Yield Per Acre, Bbls.	Per Cent Yielded Actual	Per Cent Yielded Computation
1,000	6,000	1,690	10,000	10,000
1,250	6,000	1,900	11,242	12,135
1,587	6,000	2,386	14,112	14,906
1,000	4,000	1,220	10,000	10,000
1,250	4,000	1,366	11,196	12,135
1,587	4,000	1,717	14,072	14,906
1,000	2,000	690	10,000	10,000
1,250	2,000	766	11,101	12,135
1,587	2,000	950	13,043	14,906

BARTLESVILLE-DEWEY DISTRICT (OKLAHOMA)

No. of Wells Per 10 Acres	Initial Year's Yield in Bbls.	Ultimate Yield Per Acre, Bbls.	Per Cent Yielded Actual	Per Cent Yielded Computation
0.666	4,000	987	6,950	6,878
1,000	4,000	1,420	10,000	10,000
1,428	4,000	2,000	14,081	13,619
2,000	4,000	2,260	15,915	17,990
3,333	4,000	3,250	22,901	26,215
0.666	2,000	513	6,792	6,878
1,000	2,000	770	10,000	10,000
1,428	2,000	1,100	14,285	13,619
2,000	2,000	1,220	15,844	17,990
3,333	2,000	1,727	22,298	26,215
0.666	1,000	257	6,675	6,878
1,000	1,000	385	10,000	10,000
1,428	1,000	550	14,286	13,619
2,000	1,000	632	16,415	17,990
3,333	1,000	876	22,753	26,215

The importance and application of the formula in determining the most economical spacing of wells on a property is illustrated by the computed and field data given in Table 3. These data are for four producing properties, one in each of the four oil pools Bowlegs, Earlsboro, Little River and Seminole. They give the yield of profit and oil per acre with (1) Four programs of spacing of wells, namely 2.5, 5, 10, and 20 acres per well. (2) Two well costs, namely $75,000 and $100,000. (3) Three net market prices per barrel for oil, namely $0.50, $1.00, and $1.50.

The curves represented on Chart 3 give a graphical picture of the relation of profit per acre to the acres per well.

It is seen from Table 3, for example, on the Bowlegs lease, that the average well on the lease had an initial production of 3,600 barrels, with an estimated ultimate yield of 342,000 barrels for a spacing of one well to ten acres. It is computed that the average well on this lease, for a spacing of one well to two and five-tenths acres under a proper completion and operation program, would yield an ultimate of 183,600 barrels. The yield of the average well for a spacing of one well to five acres is 273,600 barrels and for one well to 20 acres is 385,200 barrels.

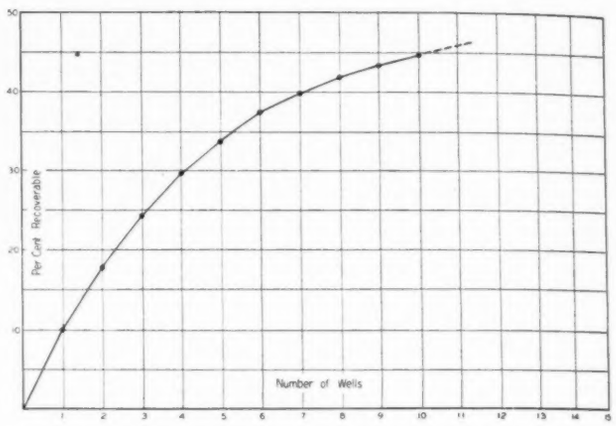

Table 3 also shows that for a net price of one dollar per barrel of oil with a well cost of $75,000, an acreage yield of 54,720 barrels would have been produced from a spacing of one well to five acres at a profit of $28,522 per acre, against an acreage yield of 34,200 barrels at a profit of $19,700 per acre from a spacing of one well to ten acres.

The table and chart reveal the fact that in general there was a great waste in the yield of profit and oil for each of the four properties, due to the improper spacing of wells. The waste would have been enormous had the spacing been wider, for example, one well to each 20 or 40 acres.

An electrically equipped shallow well.

*Actual field data tabulated from Petroleum Production Engineering, page 403, by L. C. Uren.

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Old Refrigeration Line Furnishes

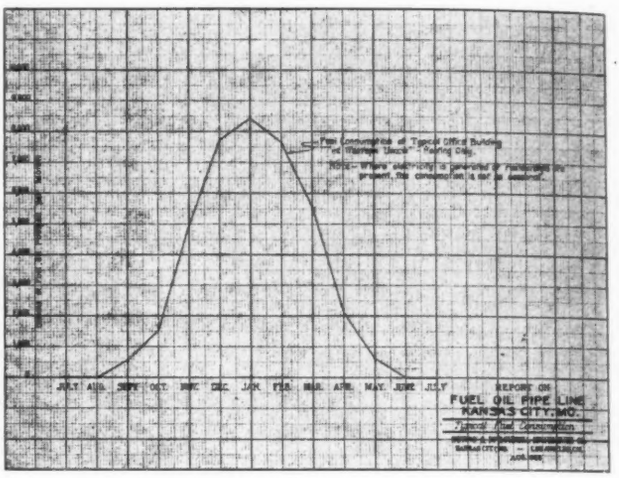
Novel System *for* Handling Fuel Oil

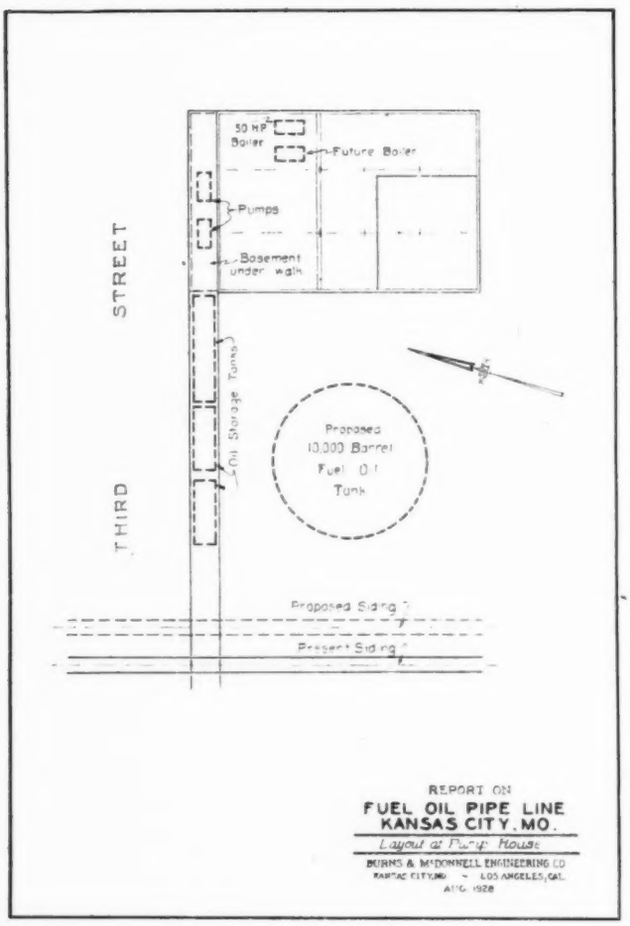
TRAFFIC congestion in the downtown district of Kansas City, Mo., resulting partly from heavy oil trucks engaged in the delivery of fuel oil to large buildings, has resulted in a widespread appeal from merchants and building owners for the use of an underground pipe line (already laid over the principal sections) to make the necessary fuel oil deliveries. The traffic way committee of the Chamber of Commerce, backed by the support of large business interests, after a review of the engineering study of the problem, has made a favorable report on the feasibility of the project.

The pipe line originally was laid in 1902. It consisted of approximately two miles of underground tile ducts 15 inches in diameter, inside of which are three steel lines now in a suitable state of repairs for use as fuel oil lines. Its original purpose was to supply refrigeration to the downtown district in the heart of Kansas City, Mo.

The power plant is situated at a point near Third Street and Broadway. From there the main line extends around the principal business district of the city. It connects with the principal buildings of the region. One arm of the system extends to the city market and a small loop is made between Ninth and Eighth Streets west of Main Street to Delaware Avenue.

The survey of the project was completed recently by the firm of Burns & McDonnell, consultant engineers, of Kansas City and Los Angeles. The survey showed that thirty-three large buildings, all with direct connections to the pipe line at the present time, now are using fuel oil and would be immediate prospective customers the moment the oil began to flow through the line. Their average annual consumption of fuel oil would be 130,000 barrels.





While they represent only the first unit of the potential service of the line, they would bring great relief to the traffic problem if they utilized the facilities of the line.

The next group of buildings within range of service from the line that now have full equipment for burning fuel oil are five in number. A third group of 18 buildings now burning coal, but which could be easily converted to oil usages if the supply were guaranteed, also are within direct range of the line. A fourth group of buildings that now are buying steam for heating purposes also are within range, and still another group, all in the area served by the line, although not equipped with boilers, are potential customers. That makes a grand total of virtually the entire center of Kansas City, Mo.

The engineering report covers only the larger buildings in name. Between them are numerous smaller buildings available to be served by the oil line and, when all are considered, the possible supply of oil would reach the astounding figure of 1,000,000 barrels per year.

Rough estimates obtained from figures available indicated that the maximum daily consumption of all the groups of buildings would be 93,000 gallons, or nine tank cars per day.

Possibilities of the pipe line project, which now has the support of the business interests of the city, are set up in detail in the report, showing that the lines can be put into first-class working condition with an expenditure of approximately $31,000.

Proceeding from the repair figure plus the estimated valuation of the line, fixed by the owners at $400,000, the engineering firm has set up a schedule showing that profits can be realized to developers of the property, after all fixed charges, including a charge of six per cent on the investment, have been taken out.

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For seven years part of the line operated by a chain of buildings that directly benefited was operated. The engineering estimate quotes building owners with the statement that fuel oil served through the pipe line would accomplish a 50 per cent saving over coal as fuel.

Since the engineers' report was filed thirty days ago, numerous business men of Kansas City have conferred with the owners on some plan to develop the property.

The piping in the line ranges from six inches in diameter at the plant down to four inches. The main portion of the four-inch system is ring-connected and thereby has the effect of two four-inch pipes. The other two pipe lines are two inches, graduated down to one and one-half inches. The valves on this line are of the ammonia type and would have to be replaced with gate valves. The insides of all the steel pipe are free from rust and the rust on the outside of the pipes is not sufficient to affect the strength of the pipes for the service intended. Standard weight steel pipe is ordinarily used where oil pressure of 800 pounds per square inch is to be used. It is doubtful that the pressure in this case will exceed 250 pounds, even though the oil were to congeal.

If the first four groups of buildings set up in the engineers' report could be obtained as customers for the new utility and the output of fuel oil be raised to the level of 300,000 barrels annually, the company could pay all fixed charges, including six per cent interest on the investment, two per cent of the gross receipts for taxes, a three per cent depreciation, all operation expenses and all rehabilitation expenses, and still undersell competition as a profit to the investors.

The potential possibilities for fuel oil connections, pointed out in the report, do not include new buildings to rise in the future, but only those either under construction or already built. Neither does the report set up smaller buildings or buildings in the wholesale district of Kansas City, which lie in the north part.

The original company failed in the refrigeration enterprise and several subsequent efforts were made to rehabilitate the property. It laid idle for several years until the sectional oil line was used over the seven-year period. Recent traffic questions, in which authorities have made a deep study for causes, drew attention to the delivery of oil by heavy trucks of various companies engaged in supplying customers. And those conclusions once again turned attention to the use of the line. The engineering survey resulted.

Service *for* Handling Pipe Minimizes Damage

TO further eliminate the danger of breaking the bond between the metal and protective coating on coupled gas lines the above pictured devices were designed and made in the shops of a Mid-Continent pipe line contractor. On a job where large diameter pipe was used the slings had a tendency to weaken or break the protective coating.

The device rigged to the wood horse is the easiest of the two to make. By shaping two pieces of strap iron to grab the bolts in the coupling and welding the chain links to it, a satisfactory device is made. The one on the steel horse is sturdier although more difficult to make. It engages in the rim of the coupling and on the welded steel horse it is easier to handle.

Two devices for raising or lowering coupled line during construction, doing away with slings which may injure the protective coating on the pipe. If the two devices do injure the coating the damage is in a place where it may be easily remedied with a daub of paint. Photographs courtesy of Williams Brothers, Inc.

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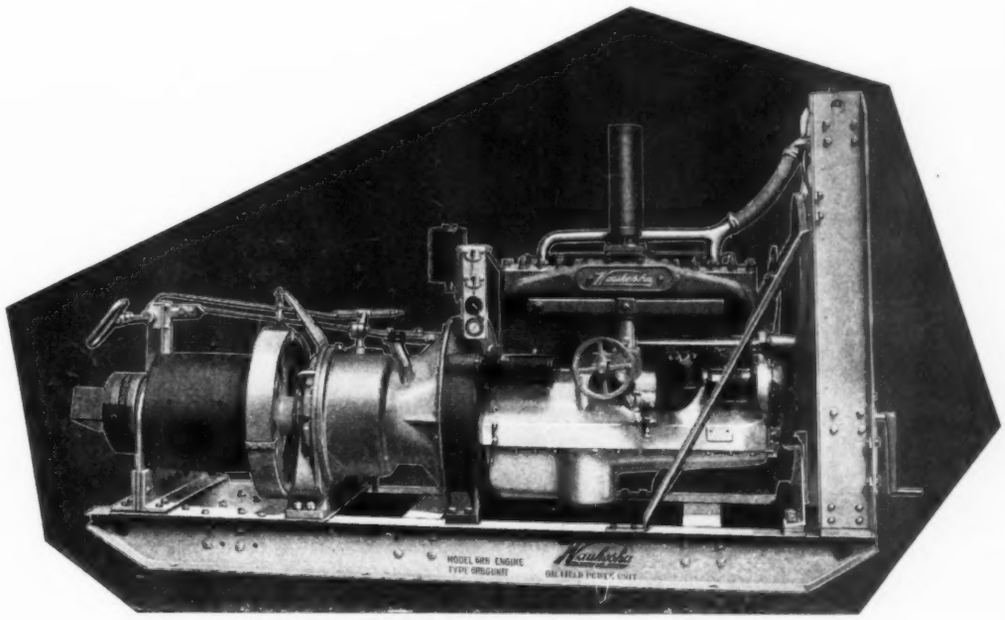

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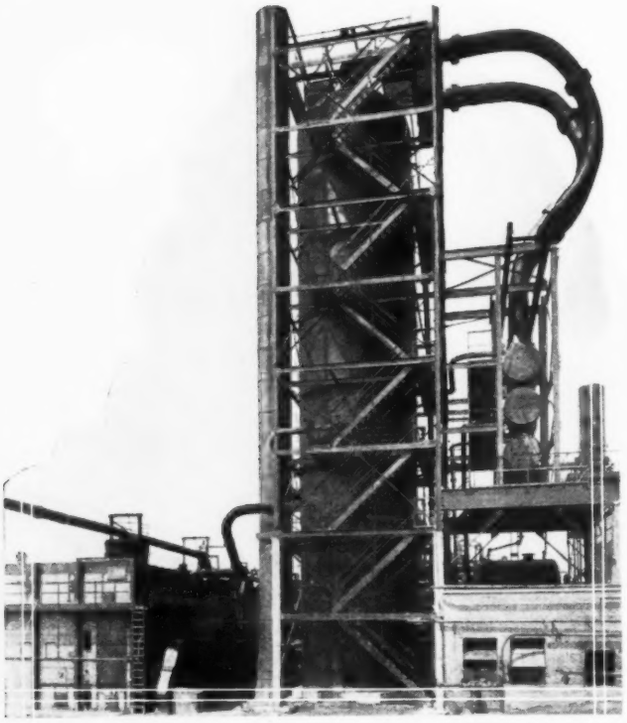


—Illustration through courtesy Foster-Wheeler Corp.

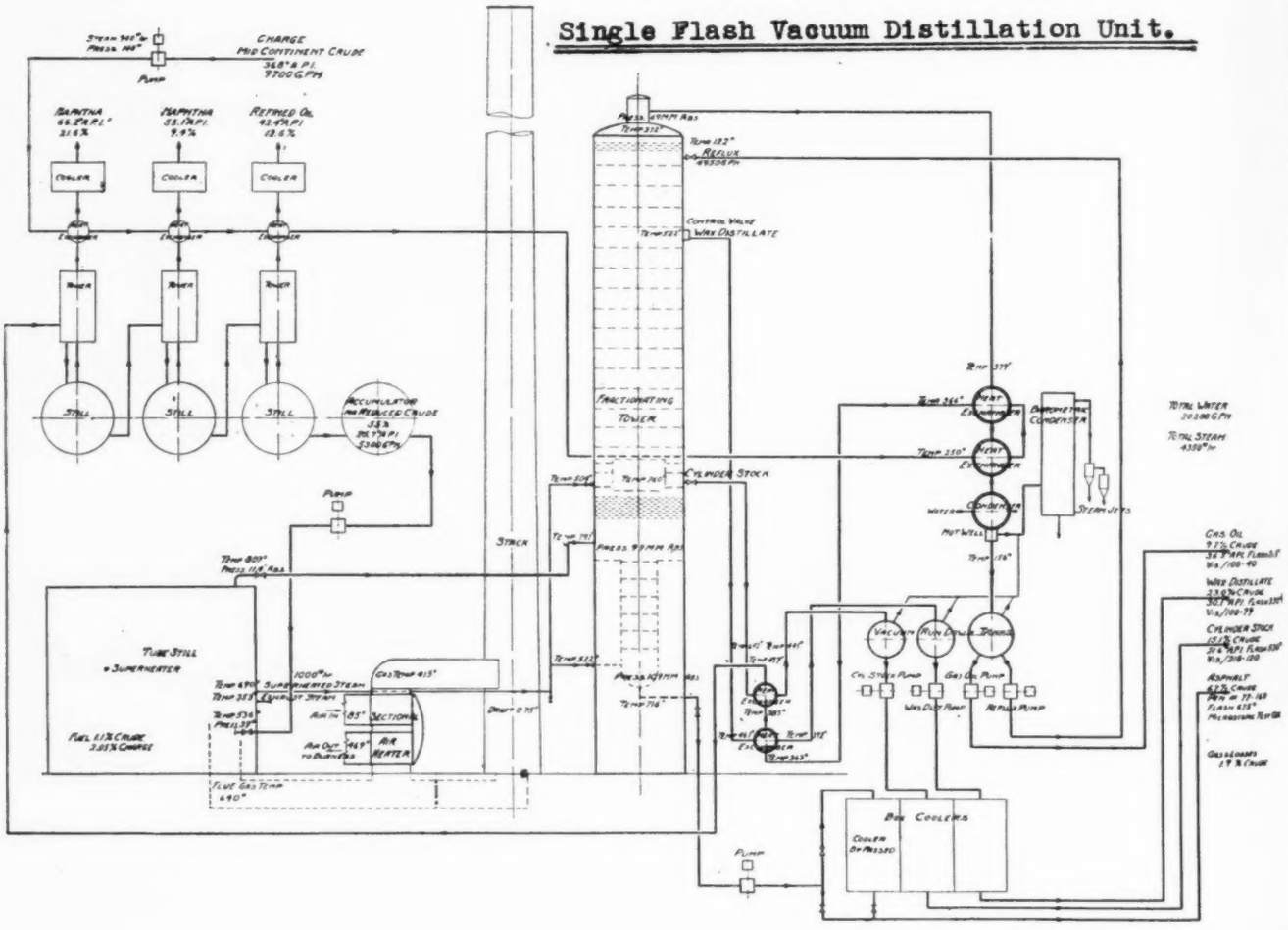
VACUUM DISTILLATION

THE accompanying flow chart shows the operation of a 5,500 barrel pipe still vacuum unit operating on Mid-Continent crude oil. The crude is charged to a battery of shell stills where 45% is taken off and the topped crude is pumped to the tube still at 530° F. with an 80% fuel efficiency. Due to the high inlet temperature of the oil, the flue gas temperature must be reduced. This is accomplished by means of an air heater which reduces the flue gas to 415° F. The oil from the tube still enters the tower. This is a vacuum bubble tower, 15 feet in diameter, and 80 feet high. The vacuum is maintained by steam jet air pumps. The overhead oil vapors are condensed in vapor condensers, and the process steam in barometric condensers.

The oil is fractionated in the tower into gas oil, pressable wax distillate, heavy lubricating distillate, and flux bottoms, the latter being about 7% of the original crude. The unit is compact and simple in operation. The fuel consumption is about 1.9% of the thruput. It was built for a West Virginia refinery by the Foster Wheeler Corporation.

Flow Chart: Mid-Continent Crude

Single Flash Vacuum Distillation Unit.



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Electrical Logs *and* Correlations *in* Drill Holes[1]

By CONRAD *and* MARCEL SCHLUMBERGER[2]

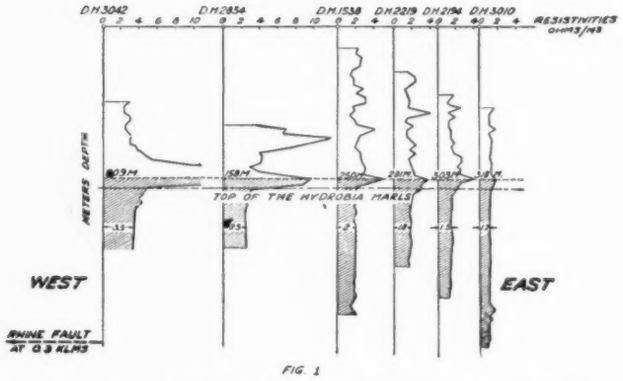


FIG. 1

Correlation between six wells situated at progressively greater distances from the Rhine fault, near Pechelbronn.

BY the term, making an "electrical log," the authors designate an operation conceived for the purpose of determining electrically the character of formations traversed in drilling, the determination being carried out by means of measuring the electrical resistivities of the rocks along the uncased portions of drill-holes. As in the case of an ordinary core record, this process envisages a geological study of the strata, and for that reason it is given a similar designation.

The paper is divided into three parts. The first deals with the resistivities of rocks in general, since it is through this electrical parameter that they are to be characterized. The second deals with the technique, and the third with the description of practical applications of the electrical logs.

Electrical Resistivities of Rock Formations

In this section the authors discuss in considerable detail the factors affecting the resistivities of various kinds of rocks. This is of no small interest to geophysicists, but to one concerned principally with the possible practical applications, parts of it are of minor moment. Consequently, the translators have summarized only the more important points so as to give a general perspective of the question.

The electrical resistivity of rocks is a parameter which is easily measured with accuracy, and one which varies between wide limits. In fact, it is not uncommon to find neighboring formations whose resistivities are in the ratio of one to one thousand. Such ratios are far larger than the ones observed by geophysical methods utilizing such physical properties of rocks as their density, elasticity, magnetic permeability, etc.

The following table conveys an idea of the magnitude of the resistivities which may be expected in various rock formations:

	Resistivities in Ohms per meter cubed
Salty formations of certain oil districts	0.2 to 10
Clays	10 to 30
Calcareous shales	20 to 40
Shaley limestone	40 to 200
Igneous and metamorphic formations	200 to 1000 and up
Rock salt	10^{15}

It should be noted, however, that knowledge of the resistivity of a formation does not necessarily imply cognizance of its petrographic character. Several different rocks may, under certain circumstances, possess about the same resistivities; and the resistivity of a given rock may sometimes vary from place to place. The reason for this is that, except for certain ore minerals which possess metallic conductivity, rock formations transmit electrical currents only because of the electrolytic conductivity of their absorbed moisture. The rock-forming minerals are themselves insulators which the current avoids as it follows the moist interstices. Therefore, the resistivity of a given rock may vary with:

1—Its water content.
2—The quantity, per unit volume, of ionized salt contained therein.
3—Its temperature. Due to the geothermic gradient, a rock at a depth of three thousand feet, for instance, is approximately two times more conductive than at the surface.

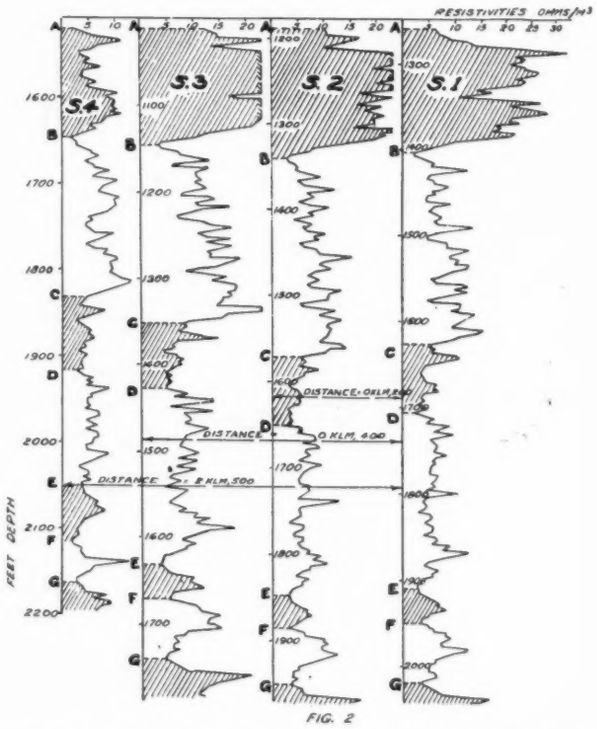


FIG. 2

Four wells, from 0.2 to 2.5 km. apart, located in a South American oil field, show typical electrical correlations.

[1] This paper was presented by the authors at the Second International Drilling Congress held at Paris in September, 1929. It has been translated and adapted for publication in Mining and Metallurgy by Henry G. Doll and Sherwin F. Kelly, Schlumberger Electrical Prospecting Methods, New York City.

[2] Société de Prospection Electrique, Procédés Schlumberger, Paris.

4—Its strike. Sedimentary rocks are anisotropic and are more conductive along the strike than perpendicular thereto.

However, a coal seam, a gypsum bed, an oil sand, are often recognizable by their very high resistivities; a salty clay, or a metallic vein, on the other hand, are characterized by a low resistivity.

Nevertheless, the resistivity of a given horizon will remain fairly constant over a considerable area. Therefore, while it is not possible to discover, unquestionably, a certain rock by means of its resistivity, it still remains true that a given formation, in general, is recognized as being the same one when encountered in two different drill holes in the same oil field, for example. Thus, if the geological column is known for one hole, it is possible to compare it with the electrical diagram of resistivities. The correspondences observed between the various kinds of rocks and their resistivities will then, as a rule, be identical for all the drill holes of that region.

Technique Employed in Making Schlumberger Electrical Logs

In order to measure the resistivity of a formation at a certain depth in a drill hole, appropriate apparatus is lowered on the end of an insulated electric cable to the given horizon. The measuring arrangement is especially designed to eliminate entirely the perturbations due to the conductivity of the water in the drill-hole and to the phenomena of polarization provoked by the current flow.

Under these conditions the readings give, very closely, the average resistivities of the formations for a certain volume of ground around the well. The depth of each reading is accurately given by the length of cable introduced into the hole.

These data permit drawing up a diagram which constitutes the *Schlumberger electrical log* in which the abscissæ represent the resistivities, and the ordinates the corresponding depths. See accompanying figures.

Several models of the apparatus used have been developed for working to various depths. The heaviest weighs about a ton, while those for shallower holes are lighter. They are usually mounted on a truck, the engine of which furnishes the power for operating the apparatus.

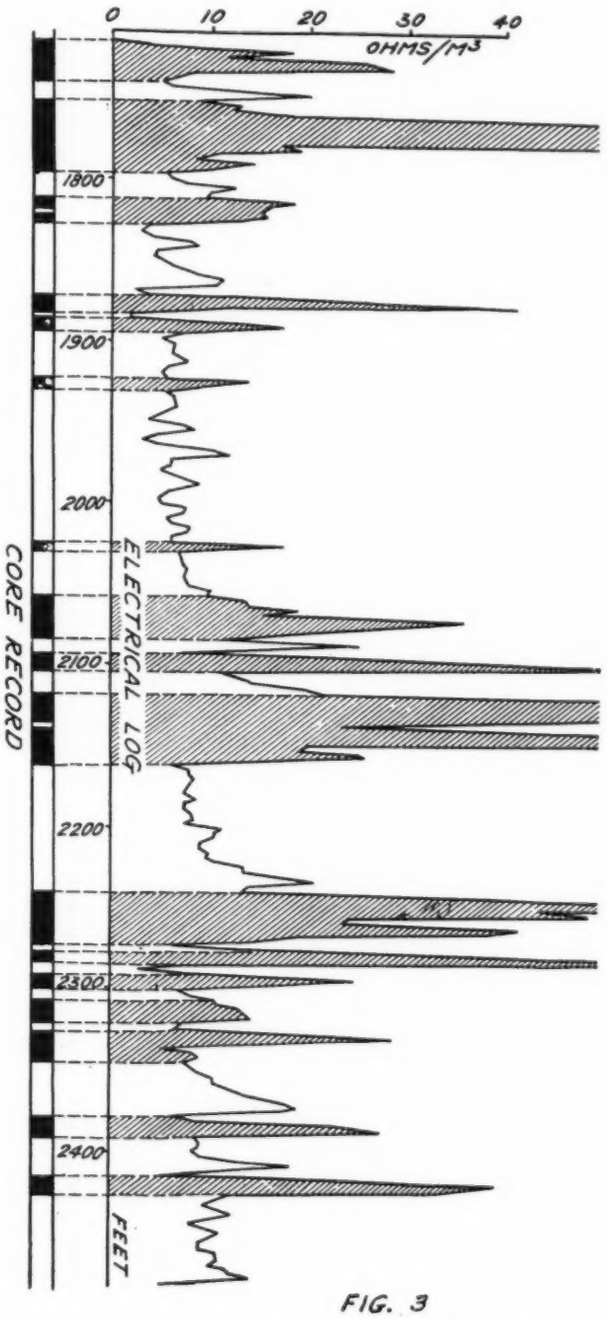


FIG. 3

Graph of resistivities, from a survey in South America, showing manner in which oil-bearing beds are characterized by their high resistivities. The agreement between electrical and mechanical methods is apparent.

Experiments have just been completed on an apparatus in which the readings are recorded secretly and automatically. Precautions against fire hazard have also been perfected so as to avoid danger in working around gas wells.

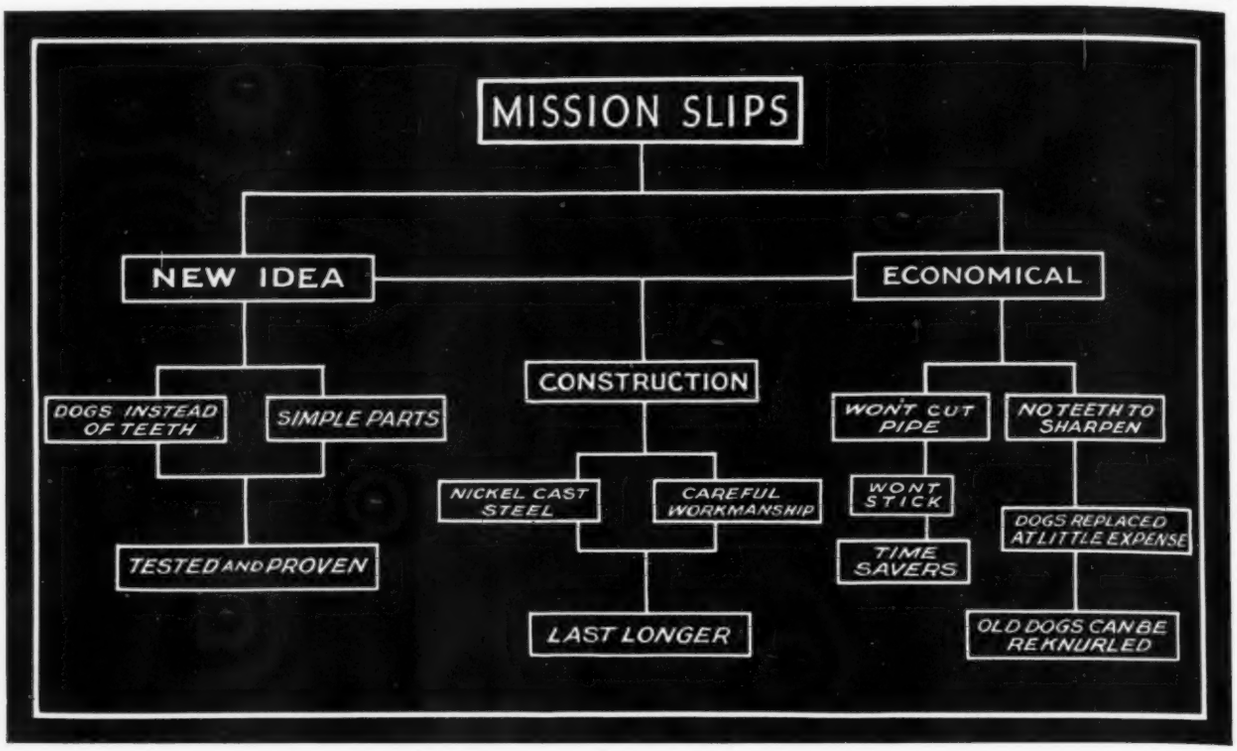
Applications of the Electrical Log

Naturally, the recovery of a core and its complete lithologic and paleontologic examination will almost always give more information than will the determination of the electrical resistivity of the rock to which it belongs. In principle, then, the electrical "core" should be considered as an auxiliary to the core of stone and is called upon to replace the latter simply because it is much cheaper, more rapid, and frequently more easily employed.

Nevertheless, under certain circumstances, the electrical log is capable of yielding various and important supplementary data which may escape unperceived in the ordinary core. This may be the case, for example, in the determination of petroleum-bearing horizons; in the detailed study of coal beds; in the search for aquifiers, etc. Also, the electrical method explores the ground for a certain radius about the drill-hole and thus makes it possible to discover a mass of ore just missed by the drill. For all these special cases it is advantageous to make an electrical log even in holes from which a core has already been pulled in order to augment and render more precise the information already obtained.[3]

In particular, consider the case of the diagnosis of oil horizons cut by the drill. The difficulty of recognizing oil sands is well known, especially when the danger from gas requires the maintaining of a heavy mud in the hole and prohibits tentative pumping. Territory thus insufficiently explored has not infrequently been abandoned when, in reality, it was potentially of great value. Even the examination of a core carefully recovered does not confer great security because oil absorbed by a sand under pressure may often escape completely before it reaches the surface.

[3] An interesting illustration of this recently occurred in a survey in Canada. The core and log of an old drill had been lost, but it was thought that the drill had cut ore. An electrical log of the hole quickly demonstrated the presence of metallically conductive material, presumably copper sulphide, and showed its exact depth and thickness.—H. G. D. and S. F. K.



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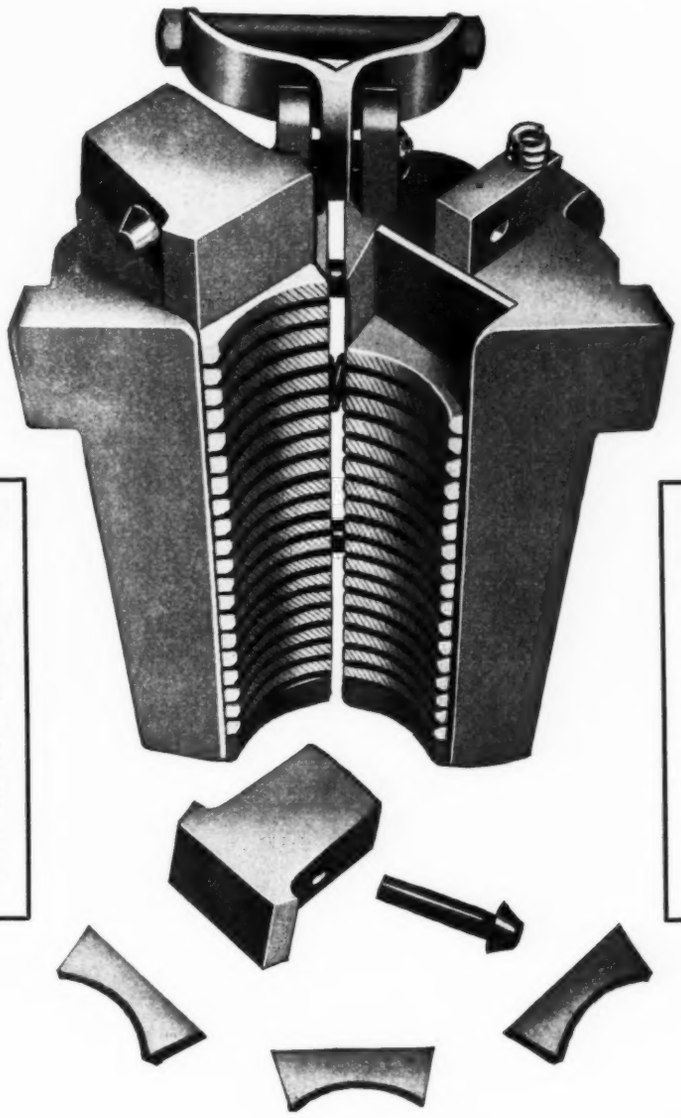

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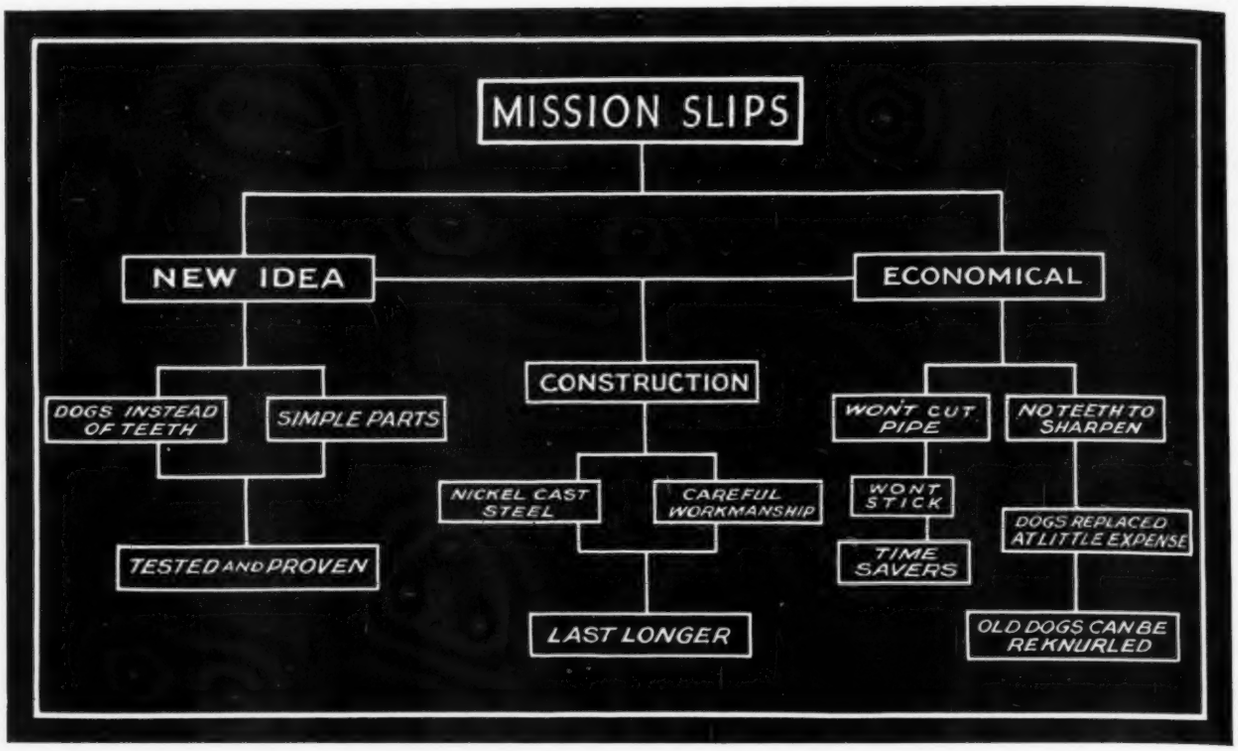

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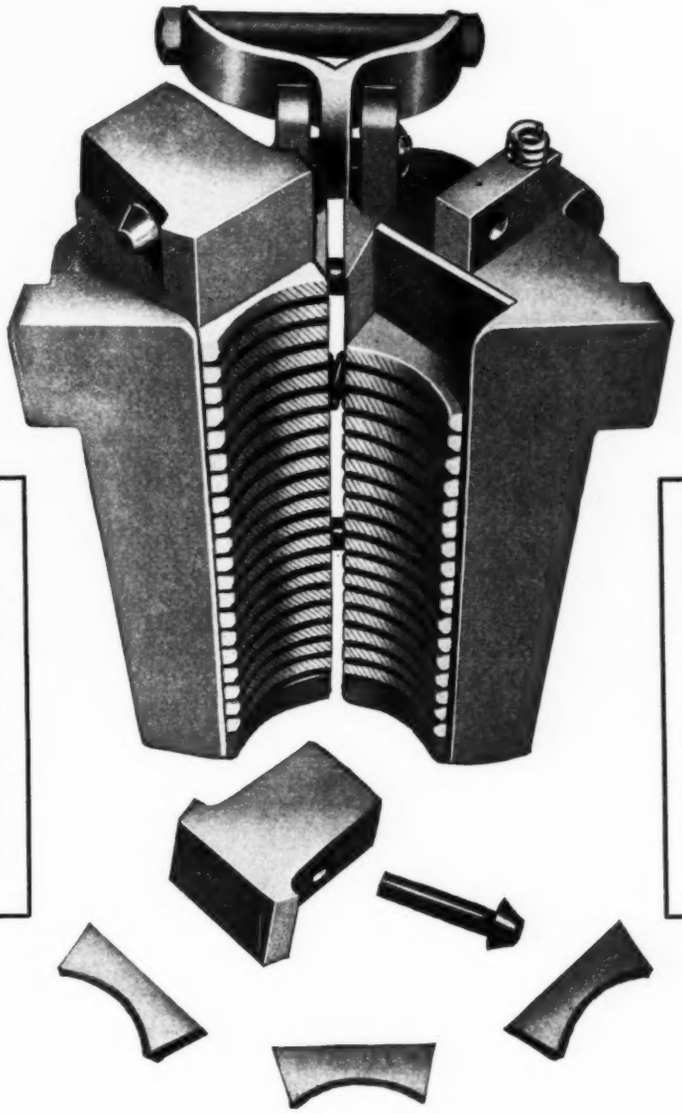

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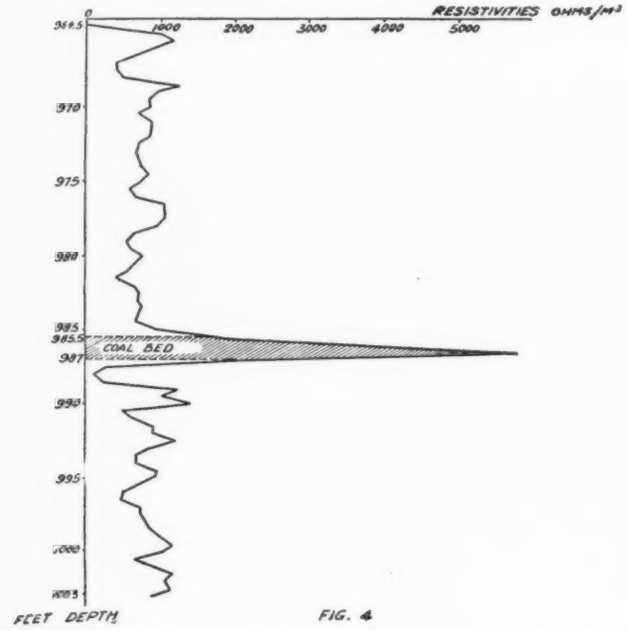


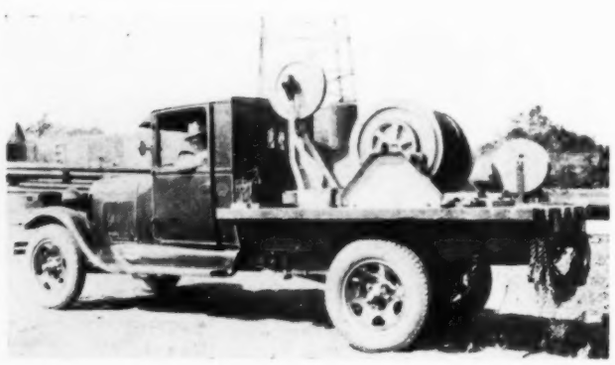
FIG. 4

Coal bed first missed by drill, then discovered electrically. (France.)

For this reason the Messrs. Schlumberger believe that the electrical examination of a hole, even when its core is complete, constitutes an important phase of application of the electrical log. The same sort of argument applies to coal-beds which, because of their friability, frequently fail to appear in the core samples recovered. One of the accompanying diagrams, Fig. 4, gives an illustration of the discovery of a coal bed missed by the drill.

Incidentally, the electrical measurements indicate at once the position of the bottom of the tubing, which may be a useful check at times.

The authors here take up the fundamental problem of the geological correlation between various drills in the same region, such as an oil field. They assume that the geological column is known, and that therefore the problem consists of determining the exact depth at which different formations are encountered in each well. In order to accomplish this it is necessary to find a certain number of good electrical horizon markers. These must have sufficiently characteristic resistivities to permit their ready recognizance and must extend, with this same quality, over a sufficiently large area to serve for the correlation of distant wells.



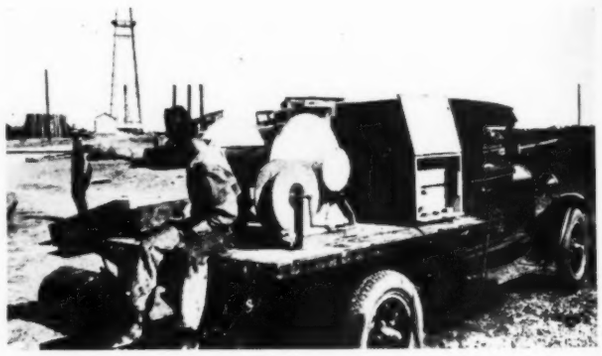
Complete Equipment.

As a rule, a horizon defined by a precise lithologic character, such as the contact between a sand and a shale, will also be a good electrical marker. Horizons distinguished solely by paleontological evidence are not electrically differentiable.

Inversely, certain good electrical horizon markers may escape observation in a core, such as a salt water-bearing sand. Also, two geological series composed of alternating sands and shales may sometimes be distinguished by the values of their average resistivities involving large volumes, whereas a simple optical examination may lead to no sure conclusion.

The above observations having been enunciated, it may be said that the problem of correlation presents itself in much the same manner, whether it is a question of coring electrically or mechanically.

The great advantage of the electrical over the mechanical log is its low cost and high speed. As a general rule, the speed is between 500 and 1000 feet per hour, so the time required for a given hole will depend on the length to be studied. Usually the cost of the work is but a small fraction of that incurred in ordinary coring. An absolute figure cannot be given, however, because it depends so much on circumstances, particularly on the amount of moving about involved. Over a year's experience, under a variety of actual industrial conditions, leads us to the conclusion that the cost per foot of the electrical log is about one-twenty-fifth of the cost of ordinary mechanical coring. This presupposes well-organized work and drills spaced closely enough to avoid loss of time and money in traveling about. Naturally, an isolated study, as of a coal bed, involves a heavier cost per foot. The loss of time consequent upon stopping the drill is of little importance, in view of the rapidity of the electrical study.

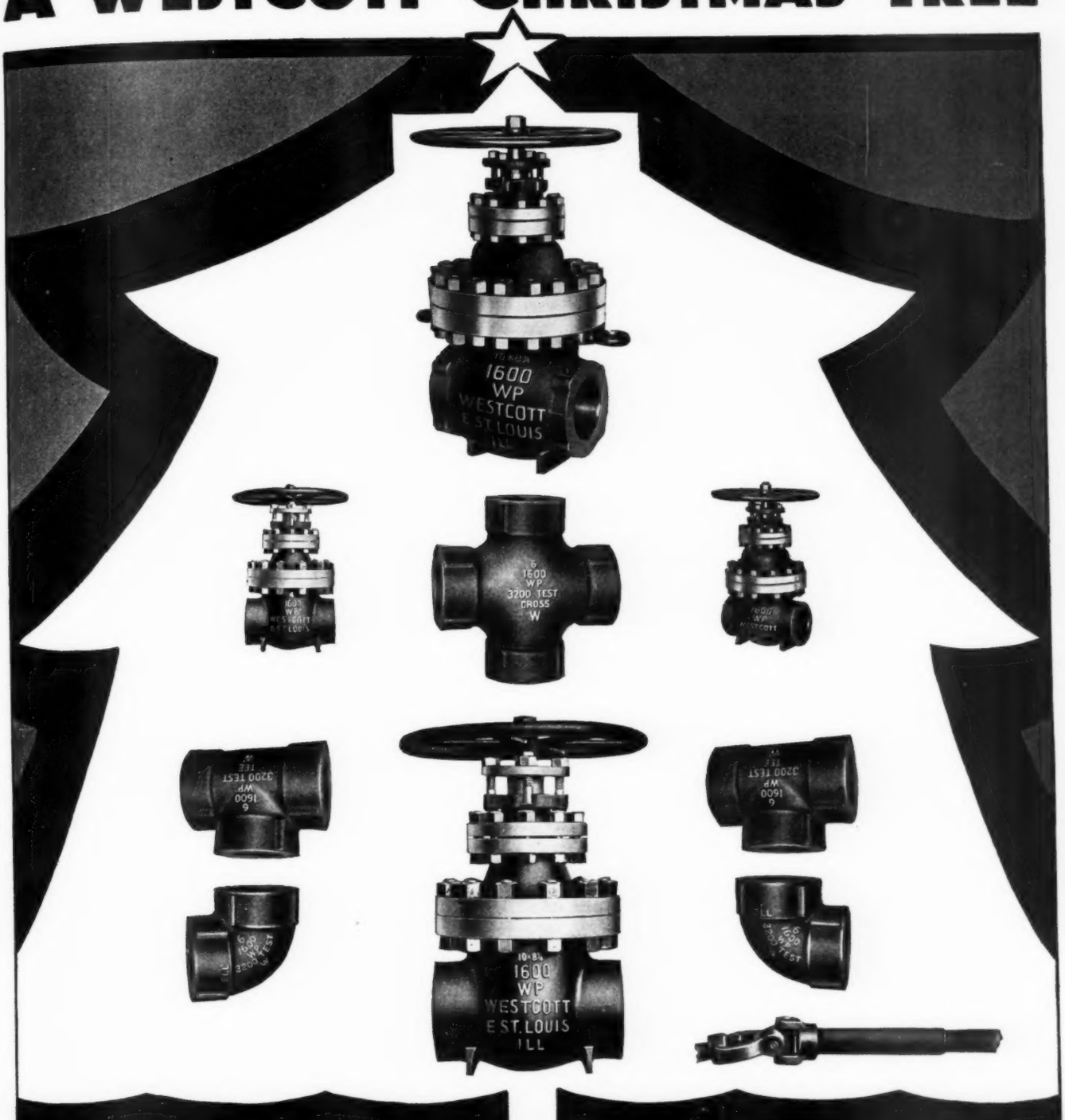


Drum, Energizer and Recording Apparatus.

The practical result of this low price is the economical possibility of making a much larger number of the electrical logs than would be feasible in the case of mechanical coring, and to limit this latter merely to the essential points. *Mechanical core recovery can even be eliminated entirely when the formations are well known and it is simply a question of fixing their depths.*

This is the case, for example, in the Pechelbronn oil field, where the electrical log has supplanted mechanical coring almost entirely. The operations there are described in some detail in the paper by C. and M. Schlumberger, since the members of the Drilling Congress planned to visit that area and would hence have the opportunity of seeing the electrical method in operation.

A WESTCOTT CHRISTMAS TREE



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Specification Changes Outlined in

Standardization Committees' Reports

THE scene of the annual meeting of the Standardization Committees of the American Petroleum Institute was shifted this year from Colorado Springs to Chicago where it was held in conjunction with the general meeting of the institute. Several important changes in the specifications of various kinds of petroleum equipment were made.

The ultimate tensile strength of oil field belting was changed from 340 to 320 pounds per inch per ply. A 100 h. p. boiler with a minimum working pressure of 175 pounds per square inch was added to the boiler specifications, and the committee on boilers tentatively adopted a 125 h. p. boiler.

The rig and derrick committee adopted a new derrick with a height of 136 feet, and a 26 foot base; and a proposal to reduce windload stipulations on derricks was rejected. A number of minor changes were made in the recommendations for concrete foundations.

In rotary drilling equipment, the committee recommended that the new grade "D" material (95,000 pounds per square inch tensile strength) be added to drill pipe specifications. The article beginning on this page presents a complete report of the Standardization Committees. —*Editor.*

Belting

A. H. RINEY, National Chairman;
L. B. HOLLAND, National Secretary.

Amendments to Specifications:

The A. P. I. Belting Committee adopted the following minor changes in the A. P. I. Belting Specifications:

(a) The ultimate tensile strength of rubber belting was reduced from 340 to 320 pounds per inch per ply.

(b) The minimum elongation curve for stitched fabric belting was lowered slightly.

(c) Section K-3 of the Fifth Edition of the Belting Specifications (dated January, 1929) was deleted entirely. This paragraph was a part of that section of the Belting Specifications dealing with inspection and rejection and provided for the testing of belting which failed after use in the field and on which laboratory tests had not been previously made.

(d) A sub-committee was appointed to prepare specifications covering the testing of belts wider than 14 inches, for consideration by the main committee at a future date.

(e) Another sub-committee was appointed to prepare specifications on a method for measuring the thickness of solid woven hair and cotton belting, to be considered by the main Committee at a later date.

Use of A. P. I. Beltings

Discussion at this meeting of the Belting Committee disclosed the fact that, although the major portion of the belting now being sold will meet the A. P. I. specifications, very little is marked with the A. P. I. monogram. In this connection the fact should be borne in mind that the right to use the A. P. I. monogram on belting has been available to manufacturers only since early in 1929. It should not be forgotten that the A. P. I. Belting Specifications in certain cases, provided for minimum values and belting must exceed those minimums in order to pass the A. P. I. Specifications. District Committee reports show that greater service is being rendered by A. P. I. belting than was obtainable before the adoption of the A. P. I. specifications. One operator has increased belt service 43 per cent in the past year over the previous year, while another reported 60 per cent decrease in belting expense after using A. P. I. belting. It has been estimated that $5,000,000 was expended for oil field belting during the year 1925 and that by proper care and use, the life of belting should be increased at least 20 per cent, equivalent to a saving of $1,000,000 per year on belting alone.

Boilers

S. J. DICKEY, National Chairman;
L. W. VOORHEES, National Secretary.

100 and 125 H. P. Boilers:

A 100 h.p. boiler, with a minimum working pressure of 175 pounds per square inch, has been added to the A. P. I. boiler specifications, and will be incorporated in the next edition. The committee also adopted tentatively a 125 h.p. boiler, together with a list of fittings for both boilers, subject to approval by letter ballot.

Stack Bonnets:

A special sub-committee of manufacturers was appointed to formulate specifications on stack bonnets for consideration by the committee at the next meeting.

General:

A proposal was rejected to change the present size and spacing of water gage cocks and openings and to reduce the number of handhole plates.

Use of A. P. I. Boilers:

A canvass of the use of A. P. I. specification boilers developed the fact that a considerable percentage of the boilers sold during the past year were of higher horsepower than stipulated in the present A. P. I. specifications. The canvass also indicated that the specifications were being generally adopted in those cases where they cover the size boiler required by the user.

Manufacturers present at this meeting stated that the final adoption of the two new sizes (100 and 125 h. p.) would permit them to meet the specifications fully, except where some purchaser expressed a preference for non-standard outlet sizes or for other items not permitted in the A. P. I. specifications.

Presented at the tenth annual A. P. I. meeting held in Chicago, December 2-6, 1929.

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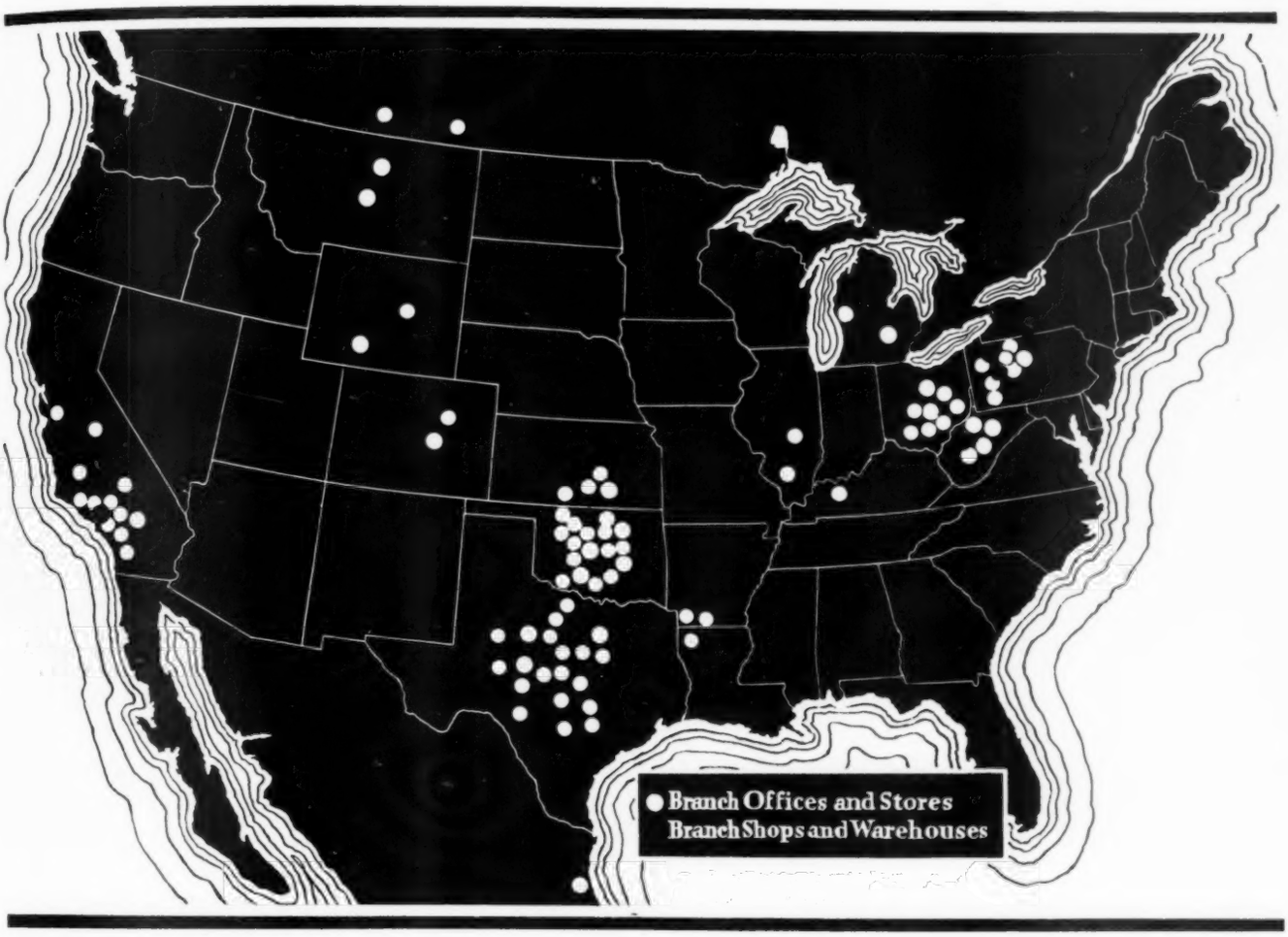

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Cable Tools

E. H. WILLIAMS, Chairman;
F. J. SPANG, National Secretary.

The Cable Tool Committee conducted a very interesting interchange test on sample joints from several manufacturers on the 3¾ inch and 4½ inch sizes. Some of the sample pieces were made from pages one element of which on projection test was beyond A. P. I. tolerances. The results show that they interchanged satisfactorily with joints made to gages that were within all of the A. P. I projection tolerances, and a suitable change in the specifications will be made to take care of this condition.

A report was made on the status of the group order on the three small sizes of cable tool gages as follows:

The 1x1½" will be completed and ready for certification by the Bureau of Standards on December 18, 1929.

The 1⅛x3¼" will be ready on January 11, 1930.

The 1½x2¼" will be ready February 1, 1930.

Rigs and Derricks

W. W. FONDREN, National Chairman;
R. W. HAMAKER, National Secretary.

136-Foot Derricks:

The A. P. I. Rig and Derrick Committee adopted a new derrick with a height of 136 feet and a 26-foot base.

Capacities of Steel Walking Beams:

The recommendations of the Steel Derrick Manufacturers' Sub-committee on the capacity of steel walking beams, as submitted at the last annual meeting, were approved at the present meeting for inclusion in the specifications.

Bullwheel and Calf-wheel Post Connections:

Standards on bull-wheel and calf-wheel post connections, recommended as tentative at the last meeting, were adopted as final at this meeting.

Wooden Derrick Specifications:

Tentative standards for nailed wood derricks, as prepared by the special sub-committee on lumber specifications, were adopted as tentative and will be incorporated in the next edition of the specifications.

A. P. I. Windload Specifications:

A proposal to reduce the windload stipulations on A. P. I. derricks was rejected, and the present spicifications wherein windload is computed with a pipe set back, were retained.

Use of Seamless Pipe in Derrick Construction:

Responding to a suggestion that the capacity formula for A. P. I. derricks be changed in order to utilize higher tensile strength now obtainable in pipe steels, steps were taken to make a study on the adaptability of the present A. P. I. column formula for use with steels having higher yield points than the A-9 steel of the American Society for Testing Materials, and if the A. P. I. formula is not applicable to the A-9 steels, a suitable formula for such steels will be sought.

Field Poster:

With slight modifications the committee adopted the recommendations of the Steel Derrick Manufacturers' Subcommittee for a poster on the care and use of derricks.

Concrete Specifications:

A number of minor changes were made in the recommendations for concrete foundations, given in A. P. I. Code No. 4: "Recommended Field Practice for the Care and Use of Standard Rigs and Derricks."

Oil Country Tubular Goods

CHAS. FITZGERALD, National Chairman;
E. P. BLY, National Secretary.

This committee took action on several items which were either referred to suitable sub-committees for further action, or were adopted subject to decision by letter ballot.

It was agreed to adopt 8-thread ¾-inch taper on 8⅝-inch casing. The matter has been under serious consideration for a long period of time and considerable information both from the field end as well as special shop tests were presented substantiating this change. It was specifically brought out, however, that when 10-thread was originally adopted for this size much lighter weights were in use. The development in later years has been toward heavier weights, thereby increasing the material under the thread.

On the recommendation of the Rotary Drilling Equipment Committee, 7⅝-inch drill pipe was approved as a tentative standard.

On the request of the Pump Equipment Committee, 1½-inch plain tubing was added to the specifications. This size is coming into use for gas lift work.

A report was presented by the special sub-committee on the special investigation of phosphorous and sulphur. It was agreed to withhold publication of this report until the report of other sections of the A. S. T. M. joint committee on this same subject were available.

Rig Irons

H. J. LOCKHART, National Chairman;
O. H. ATTRIDGE, National Secretary.

Saddles:

The dimensions for dowel pins on saddles, adopted as tentative at the last annual meeting, were approved as final at the present meeting of the Rig Iron Committee.

Tug Pulley Keyways for 6-inch Shafts:

A proposal was received by the committee that the tug-pulley keyways stipulated for 6-inch shafts be deleted from the specifications. After discussion it was decided to retain these keyways on the shaft, but to designate them as "Accessory" keyways and to shift them to a position on the upper side of the shaft, spaced equally on either side of a vertical center line parallel to the crank when it hangs downward, in order to facilitate the removal of flanges, sprockets, etc.

Field Posters:

The committee adopted a poster covering the proper care and use of Rig Irons in the field.

Rotary Drilling Equipment

E. J. NICKLOS, National Chairman;
F. E. BERNSEN, National Secretary.

Drill Pipes:

(a) It was recommended that the new grade "D" material (95,000 lbs. per square inch tensile strength) be added to the drill pipe section of the A. P. I. pipe specifications.

(b) The 15 degree bevel on the outside ends of drill pipe was increased to 25 degrees.

(c) The 8⅝-inch drill pipe adopted as tentative at the Ninth Annual A. P. I. meeting, was retained as tentative, and at the present meeting 7⅝-inch drill pipe was also added to the specifications as tentative.

Rotary Taper Tool Joints:

(a) The committee decided to await further field tests on the 3½-inch size joints before taking further action.

(b) The previously adopted tentative stipulation of 4½ threads for stand-off on the 5-9/16 inch and 6-⅝-inch joints was withdrawn. This action also automatically rescinds the tentative counter-bore of 9/16 inch on these two sizes. A special supplement will be issued giving a full explanation of this question.

(c) The committee further decided that rotary tools carrying the standard A. P. I. threaded pin or box, and not listed in the specification, might be marked with the size

and the letters "A. P. I.", but not with the monogram, in order that proper identification thereof might be made in the field.

(d) The committee reported that all rotary tool joint right-hand gages in the group order had been shipped with the exception of the 3½ inch, which is still held up. All left-hand gages have been shipped except the 2⅜ inch sizes will be shipped within the next three or four weeks.

(e) The inner counter-bore on the pipe end of tool joints was eliminated, in order to provide more stock for re-threading.

(f) A request was received for standards on flush tool joints, which was referred to the Manufacturers' Sub-committee to submit tentative recommendations at a future meeting.

Grief (Driving) Stems:

(a) It was decided to include 7-inch square and 7-inch "V" groove grief stems in the specifications, and the details thereon were referred to the Manufacturers' Sub-committee.

(b) No agreement was reached by the committee as to the grief stem lengths and the matter was referred to the various districts for further study and report.

Large Sizes of Shafting:

The committee adopted 6½ and 7-inch shafting at a previous meeting and at the present meeting it was decided to include 7½ and 8-inch shaftings in the specifications. The details on keys and keyways was referred to the Manufacturers' Sub-committee for report at a future meeting.

Sprocket Tooth Form:

It was decided at the Ninth Annual A. P. I. meeting to reopen the subject of standard design for sprocket tooth. At the present meeting tentative designs were submitted and recommended for field try-outs, which will be reported at the next meeting of the Institute.

Wire Rope and Manila Cordage

C. C. SCHARPENBERG, National Chairman;
DONALD E. DICKEY, National Secretary.

Manila Cordage Section

Depth of Bull Rope Grooves:

In paragraph B-2 of the Manila Cordage Specification, on "Bull Rope Grooves," the minimum depth of grooves is set at 2⅛ inches; this value was changed to 1⅞ inches minimum at the present meeting, with the recommendation that where practicable, slightly deeper grooves be rolled so that at no time would the ropes ride in the bottom of the groove.

Use of A. P. I. Monogram on Cordage:

It has been proposed that the A. P. I. monogram be used on Manila Cordage manufactured in accordance with the A. P. I. specifications; after discussion on this point the committee reached the conclusion that the use of the A. P. I. monogram should not be permitted at the present time. The committee expressed the hope that purchasers would continue to order Manila Cordage according to A. P. I. specifications in increasing amount, with the thought that permission to use the monogram on Manila Cordage might be authorized at some later date.

Listing of Testing Laboratories:

It was decided to include in the next edition of the Manila Cordage Specifications a list of laboratories equipped for testing Manila Cordage.

Wire Rope Section

Maximum Tensile Strength Requirements:

It was proposed at the Ninth Annual Meeting held in Chicago, December, 1928, that the maximum tensile strength requirements on individual wires (Table 1, page 6, Sixth edition A. P. I. Standards No. 9-A; "Specifications for Wire Rope") be eliminated from the specification. This matter was discussed at the present meeting and after hearing reports of the Engineering Sub-committee on Research and of the Manufacturers' Sub-committee, it was decided that no action should be taken, pending further reports from the Manufacturers' Sub-committee.

Proposed Elimination of Bend Test:

It was also proposed at the Ninth Annual meeting that the bend test (Paragraphs 7-A, 7-B and 7-C and Tables 5 and 6) be eliminated from the specifications. At the present meeting, it was decided to retain the bend test in the specifications for the present, and the committee agreed with the recommendations of the Engineering Sub-committee on Research, that no rope be condemned by the bend test because of the difficulties experienced by the operators in bending hand-straightened wire. Further investigation of the improvements in bend test equipment was recommended.

Torsion Test:

The fourth sentence in Paragraph 6-A: "Torsion Tests of Wire," was amended by the elimination of the minimum speed of rotation, making this sentence now read as follows:

"The speed of rotation shall not exceed 60 twists per minute."

Paragraph 6-A was further amended by the elimination of the fifth sentence, which read as follows:

"If the temperature of the wire increases perceptibly, the speed shall be decreased."

Wire Line Duty:

The question of a wire line duty record form was discussed at length and a sub-committee was appointed to investigate the matter and report at a later date. A report on this subject presented by the Engineering Committee on Research showed that the cost of lines four years ago, amounting to approximately 7½ per cent of the total cost of the well, has been reduced to only 3½ per cent, while the cost of lines running over large blocks was only 41 per cent of the cost of lines running over small blocks. This report of the Research Sub-committee stated further that with former practice a 16-inch rotary drum was used, whereas with the present practice, the cost of rope has been much reduced by the use of 25 and 26 inch diameter drums.

Ultimate Strength of Wire Rope:

The Wire Rope Manufacturers' Sub-committee reported that the breaking strength of wire rope, as generally listed in trade catalogs, has been changed from the "approximate" breaking strengths to "actual" breaking strengths, and these changes will be incorporated in the next edition of the wire rope specifications; this will result in a slight increase in the tabulated values of ultimate strengths given in tables 7 and 8 of the specifications.

Use of A. P. I. Monogram:

The committee authorized the use of the A. P. I. monogram on wire rope manufactured in accordance with the specifications.

Pumping Equipment

T. E. SWIGART, National Chairman;
H. N. MARSH, National Secretary.

1. *Working Barrels and Pump Parts—A. P. I. Standards 11-A and 11-E:*

(a) *Working barrel gaging practice:*

After discussing proposed methods for gaging barrels and liners throughout their entire length, the committee decided to retain the present "Go" gaging methods but stipulated that the governing dimensions should be those now given in the specifications for the product, subject to any accurate gaging method. Investigations will be con-

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tinued leading toward the establishment of a complete gaging system, and manufacturers and operators are requested to utilize in their operations the various gaging methods presented to the committee in order that the best possible system may be finally obtained.

(b) *Standards on Inserted Working Barrels and Pump Parts:*

A sub-committee report was presented giving dimensions proposed by one district, which will be submitted to other districts for further recommendations and report.

(c) *Re-ground Working Barrel Liners and Plungers:*

The committee adopted a scale of steps and tolerances to be used in re-grinding working barrel liners and plungers, which will be inserted in the next edition of the specifications.

(d) *Tolerances for Ground Steel Plungers:*

The committee adopted tolerances of plus zero, minus 0.0005″ for ground steel plunger tolerances, which will be inserted in the next edition of A. P. I. Stds. No. 11-E; "Working Barrel Pump Parts."

2. *Sucker Rods:*

(a) *Thread Protectors for Sucker Rod Joints:*

The committee adopted a resolution providing for the use of protectors on sucker rod pins and boxes in transit from manufacturere to purchaser, the type of protector being at the manufacturer's option.

(b) *Sucker Rod Gaging Practice:*

The A. P. I. sucker rod gaging practice, as now written in the specifications, provides that the "No Go" sucker rod box gage shall not enter the product box. At this meeting it was agreed to permit this "No Go" gage to enter the products box by one and one-half turns, which is in accordance with the National Screw Thread Commission Specifications. This amendment to the sucker rod specifications does not affect existing gages nor make necessary any new gages.

(c) *Tolerances on Sucker Rod Boxes:*

A proposal to increase the tolerances on A. P. I. sucker rod boxes from plus 0.002″ to plus 0.003″ was rejected.

(d) *⅞-inch Sucker Rod Coupling Dimensions:*

A suggestion to reduce the outside diameter of the ⅞ inch sucker rod couplings, in order to permit fishing when run in 2½-inch tubing, was rejected as not absolutely necessary.

(e) *Status of Group Order on Sucker Rod Gages:*

All domestic sucker rod gages in the group order had been shipped as of July 31, 1929.

3. *Internal Combustion Engines and Clutches—A. P. I. Standards No. 11-C:*

(a) *Engine Ratings "B" and "C":*

It was decided to eliminate paragraph 8-B-3 of A. P. I. Standards No. 11-C and to revise paragraph 8-B-2 in order to allow the points of maximum power and of maximum safe speed to coincide.

(b) *Flange Connections.*

The committee approved the decision reached by letter ballot prior to the meeting to the effect that the specifications should be amended to show the projection on the flywheel hub instead of on the clutch flange as now stipulated.

Another suggestion was to use only one size (16-in.) for the flange connection, which was rejected.

(c) *Engine Foundation Bolts:*

A proposal to change the size of engine foundation bolts for the smaller engines from 1 inch to 1¼ inches was rejected.

4. *Pull Rods and Couplings—A. P. I. Standards No. 11-D:*

(a) *Standards on 1-Inch Pull Rods:*

Dimensions on 1-inch pull rods were adopted by the committee and will be incorporated in the next edition of the specifications.

(b) *Tolerances and Additional Dimensions on Pull Rods and Couplings:*

The committee adopted tolerances on certain pull rod and coupling dimension given in Table 2 of A. P. I. Standards No. 11-D, together with two new dimensions, as follows:

Dimension "J"—Minimum distance between ends of rods when assembled in the coupling.

Dimension "K"—Minimum diameter of counter-bore in coupling.

(c) *Stuffing Boxes for Polished Rods:*

The Committee adopted a standard bore of 2¼ inches on tubing head stuffing boxes for use with either the 1⅛ or the 1¼-inch A. P. I. polished rod.

5. *Electric Motors:*

(a) *Electric Motor Frame Dimensions—A. P. I. Standards No. 11-F:*

The Committee approved a proposed standard of the American Standards Association for electric motor frame dimensions and was informed that a standard for oil well type motors would be presented for consideration of the A. P. I. at an early date.

(b) *A. P. I. Rating Form for Electric Motors:*

The Committee voted to print on thin paper the Standard A. P. I. Test Form for electric motors hitherto printed on heavy paper. This change will make the form available for blue-printing. The Torque Scales on the higher power rating chart were also changed to show a maximum of 600 instead of 400 per cent of rated load.

6. *Screen Pipe Slot Designations and Tolerances:*

A tolerance of plus or minus 0.001 inch was adopted for slots having a width under 0.040 inch.

7. *Tubing:*

(a) *One and One-half Inch Plain Tubing:*

The Committee adopted dimensions for 1½-inch plain tubing for use inside 2½-inch upset tubing and recommended to the A. P. I. Tubular Good Committee the inclusion of these standards in the A. P. I. Pipe Specifications.

(b) *Protectors for Tubing Coupling Threads:*

The Committee adopted a resolution which was forwarded to the Pipe Committee, requesting the insertion in the pipe specification of a provision for tubing coupling protectors.

(c) *Marking on Tubing:*

A recommendation was forwarded to the A. P. I. Pipe Committee that a standard position on the pipe be stipulated for the location of the manufacturer's identifying mark on tubing, in order to facilitate finding the mark.

8. *Rating of Counterbalance for Pump Wells:*

Discussion at this meeting disclosed the desirability for a rating form for rotary counterbalances in order to guide the manufacturer in supplying the purchaser essential data in a uniform manner, and such a form was adopted for inclusion in A. P. I. Standards No. 11-D.

9. *Codes on Care and Use of Equipment in the Fields:*

Tentative codes on gas engines, pumps and sucker rods are in various stages of preparation and were submitted in tentative form. These codes will be further developed, and may be available for publication during the coming year.

Tanks

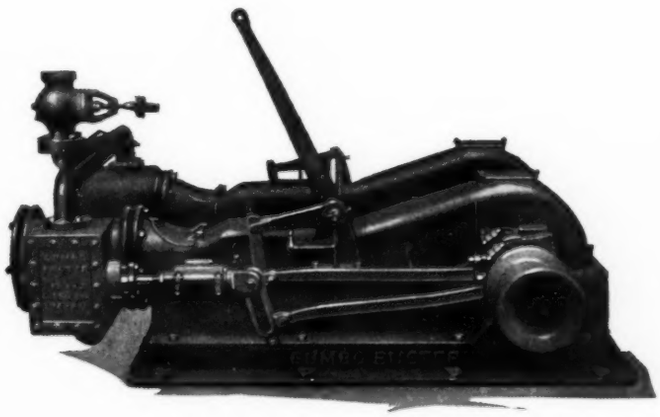
RALPH J. REED, National Chairman;
G. O. WILSON, Chairman Presiding;
MARK W. DAW, National Secretary.

An informal session of the A. P. I. Tank Committee was held during the tenth Annual A. P. I. meeting. A special sub-committee was appointed to investigate the standardization of small welded field production tanks. A number of questions were discussed by the members present, and it was agreed to submit them to the committee membership by letter ballot at a later date.

48½%

OF ALL ENGINES IN OKLAHOMA CITY FIELD ARE

"GUMBO BUSTERS"



A recent survey of the new Oklahoma City field, where highest steam pressures are needed and severest drilling conditions are encountered, shows that 48½% of all the engines in use are "Gumbo Busters."

The "Gumbo Buster" 12" x 12" Twin Cylinder Drilling Engine with flat slide valves prevents wet steam from injuring steam end of engine for this type of valve unseats while the piston valve will not unseat when a shot of water strikes it. This eliminates the necessity of heavy steam traps, etc.

This is the first engine to be enclosed. Working parts run in a bath of oil, insuring constant lubrication. Dirt cannot get into parts.

The heavy forged one-piece double-throw crankshaft is fully supported, positively reducing whip and vibration. Outside valve rigging is protected and easily adjusted or repaired.

By attaching regular flywheel engine can operate in emergency on one cylinder. This feature may prevent the loss of a well should one cylinder break down while the drill pipe is in the hole.

For over forty years the manufacturers of this engine have been producing the best of oil field rotary equipment. The figure shown in the survey above tells you that *48½% of the contractors in this field can't be wrong.*

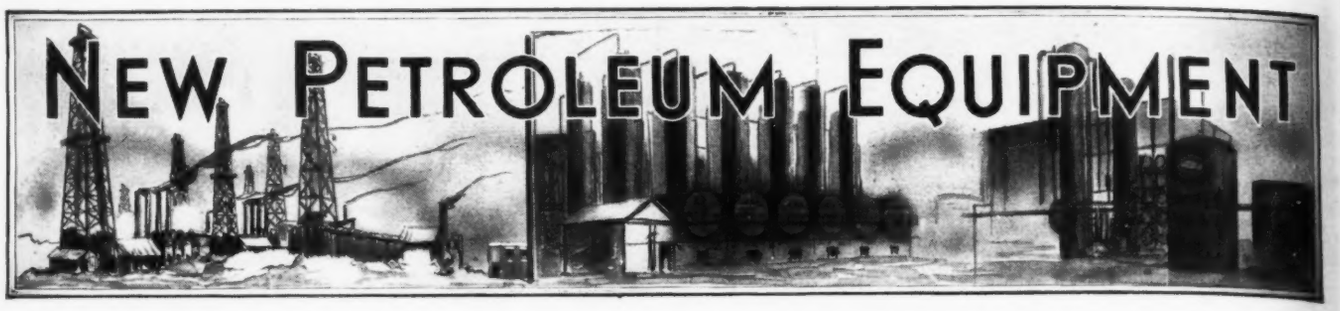
Write today for details on this light weight, compact and economically operated engine.

Republic Supply Company

OIL AND GAS WELL SUPPLIES

Cable and Rotary Tools

GENERAL OFFICES: HOUSTON, TEXAS



Casing Head

THE Hercules Casing Head, featured by the Hercules Tool Co., Tulsa, has slips for two strings of casing. It supports the inside string of pipe on slips using the Hercules method of packing off around the casing. With its new

principles and positive grip slips, it is said to afford absolute casing protection and it permits the operator to raise or lower the casing at will by removing the packing nut, packing and slips. The casing head can be repacked at any time without picking up casing.

The inside diameter of the casing head is the same as that of the larger string of casing on which the casing head is set up. Either three or four slips, depending on size, are used within the casing head to support the inside string of casing. On top of the slips and within the casing head, ample space has been provided for the rubber packing. This packing is compressed down into the casing head, and chain tongs are the only tools necessary to connect the entire set-up. The casing head is provided with two side outlets threaded for 3-inch pipe.

The body and slips are made of electric cast steel and have a safety factor of 2,500 pounds pressure to the square inch, with sufficient strength to carry a hanging weight of approximately 300,000 pounds. The fact that the inside diameter of the casing head is the same as that of the larger string of casing on which the head is screwed allows the coupling on the inside string to pass through when running or pulling without interference.

To raise or lower the inside string of casing the workman unscrews the packing nut, removes the rubber packing and slips, then either raises or lowers the casing to the point desired, replaces the slips and packing rings and screws packing nut back into place. The use of the Hercules Casing Head eliminates the necessity of using casing clamps, spiders and other equipment, with a great saving to the operator in cost of equipment.

The company also makes a forged steel casing head with three rubber packing rings for extra high-pressure wells for a small additional cost. The packing nut is split (two halves) so that it can be removed at any time without lifting the casing. The casing head is made for all standard sizes regular and A. P. I. Casing.

The Goodyear Compass Endless Cord Belt

THE Goodyear Compass endless belt, a new design of endless cord transmission belt, was recently announced by the Goodyear Tire and Rubber Company, Inc., Akron, Ohio.

The Compass belt, according to the manufacturer, differs from ordinary fabric belts, made endless with a splice, in that it has no splice in the core of cords which carries the load. The cords are imbedded in rubber, and are covered by an elastic, rubberized, fabric envelope. This envelope takes all of the surface wear, and since it is elastic, all of the load is properly thrown on the load carrying cords.

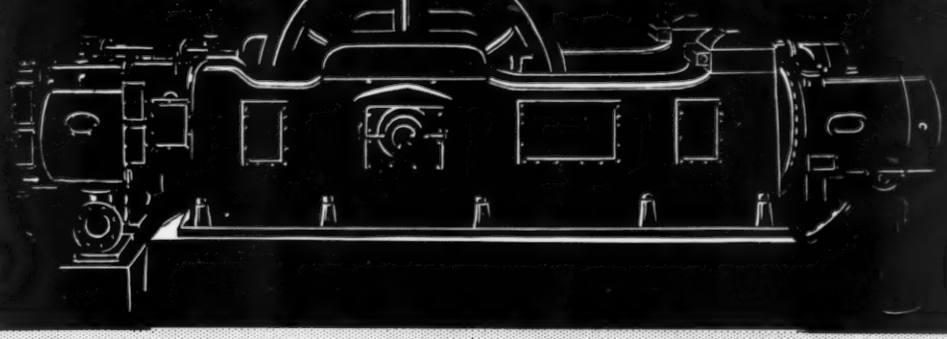
The Goodyear Compass belt is practically stretchless, extremely flexible, and much thinner than previous belt designs of equal power capacity. It is recommended by the manu-

facturer for belt drives on such equipment as air compressors, vacuum pumps, rock drills, ice machines, feed grinders, wood cleaners, spinning frames, Lenix drives, Pullmax drives, and other high speed, small pulley drives.

The Compass belt also is furnished by the manufacturer in cut lengths for oil field work and for cone drives in textile plants.

THE Reed Roller Bit Company announces the establishment of a service plant branch and warehouse to serve the petroleum industry of the state of Oklahoma. This store and warehouse is located at 1129 East G Street, Oklahoma City, Oklahoma. Russell H. Giesey has been named branch manager for the state of Oklahoma, succeeding E. E. Deacon, resigned. Frank P. Carr will be in the field, calling on the trade. Dan Delhomme will be branch engineer and Dallas J. Matthews, Jr., will be in charge of the Oklahoma City store.

TYPE-10



100 TO 200 B.H.P.

A BETTER ENGINE
...*in seven major ways:*

1 A one-piece bed.

2 A full water jacket from cylinder end to end, and improved water circulation.

3 Increased exhaust and inlet port capacity and wider bridges.

4 Greater scavenging valve capacity.

5 Improved type piston and cylinder head.

6 Better lubrication for exhaust bridges.

7 Gas economizer gives fuel economy comparable to a 4-cycle engine.

All of which results in greater overload capacity and longer life with less upkeep expense.

The Cooper-Bessemer Corporation

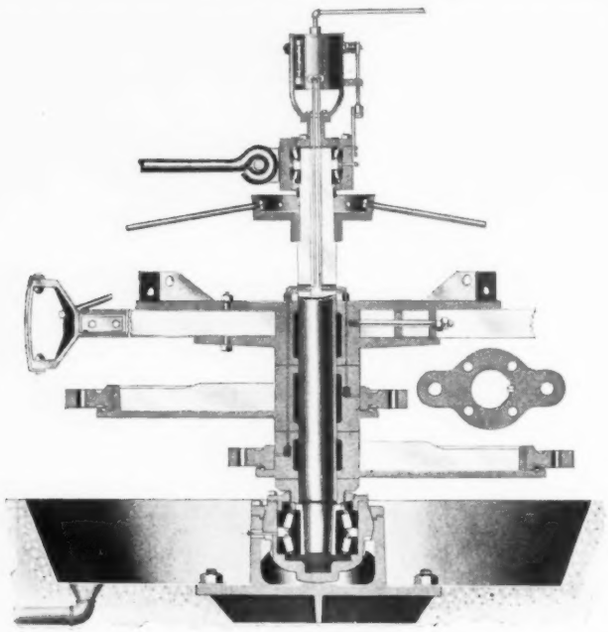
Formerly The C. & G. Cooper Company and The Bessemer Gas Engine Company

Mount Vernon, Ohio Grove City, Pa.

Branches in all principal oil and gas fields

THE Union Machine Company, Bartlesville, Okla., has recently developed a new type bandwheel pumping power of improved design. The power is suitable for pumping a number of wells, and may be driven by either an internal combustion engine, or electric motor of horsepowers up to 75, depending on the number of wells to be handled. In designing the powers, construction has been kept as simple as possible consistent with strength and rigidity.

The powers are of the revolving shaft, underpull type, the hubs of the bandwheel and eccentrics being firmly keyed to the shaft, and to each other to form a solid unit. The base is a heavy cast iron plate having the lower bearing support cast integral with it. There is also a vertical bracing and supporting member cast on the bottom of the brace. The bandwheel is of all steel construction with channel steel spokes braced and supported by heavy tie rods which run to



a circular plate, the wheel hub. The spokes are wedged into the hub, and held in place by heavy stud bolts. The bandwheel rim is made of a rolled steel section, with a crowned face. This construction lightens the wheel without sacrificing strength.

The shaft is mounted in Timken Bearings, the lower, or step bearing, being of the type developed for railroad service, and having unusually high load carrying capacity. It is mounted in a self-aligning housing, to allow for possible mis-alignment when the power is installed. The outer support is split to facilitate assembly in the field.

"Oilwell" Syphon Equipped High Pressure Boiler

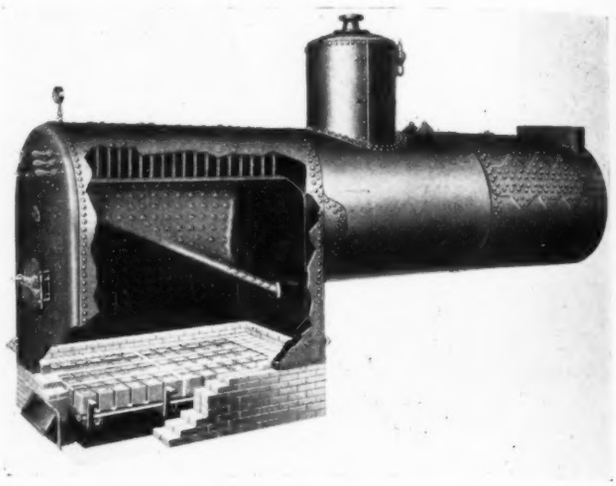
"OILWELL" announces the manufacture of a new high pressure boiler for use in deep drilling and for extreme service.

Many new features and improvements have been incorporated in this boiler to meet the demands for higher pressure with safety.

An 84-inch open bottom type firebox with a solid forged steel mud ring and equipped with a Nicholson Thermic Syphon promotes improved service at a low operating cost. The syphon adds 20% more heating surface to the firebox and increases the water circulation. This action produces steam easily and rapidly and increases the capacity of the boiler with a reduction in fuel consumption. The syphon also acts as a rigid support to the crown sheet.

Two and one-quarter inch copper-bearing steel seamless boiler tubes are used and are set in copper ferrules, beaded and prossered in the firebox tube sheet, providing 15% to 35% greater heat transmission, depending on the pressure of the flue gas. The tubes are arranged in vertical and horizontal rows providing a self-cleaning effect.

The shell butt straps are of the saw tooth type, giving the



greatest possible efficiency and strength to the joint, with the least possible weight.

Wash out plugs are conveniently located in the smokebox flue sheet for the purpose of washing off the bank of flues from several positions. Hand-hole and man-hole plates and all fittings are forged steel and of the marine type.

These boilers are now ready for distribution.

THERE are possibly more arguments in connection with the proper method of setting pump jacks to get a desired stroke with a given eccentric movement than originate in connection with any other material or machinery on a powered property.

Recognizing this fact W. C. Norris, manufacturer of Tulsa and Ft. Worth, has prepared for the users of his pump jacks complete engineering data, setting plans, and charts showing all possible combinations and their results.

This data is provided in the form of charts, is easily understood and should be of great value to the pumper that desires maximum efficiency from his installation.

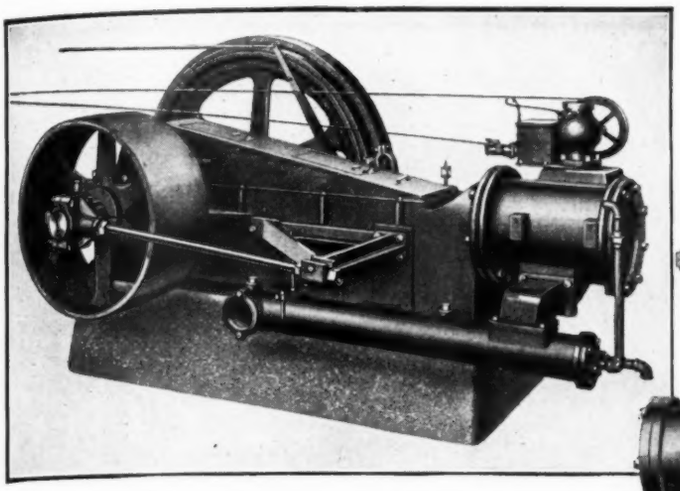
These stroke charts will be gladly furnished upon request.

Sucker Rod Hook

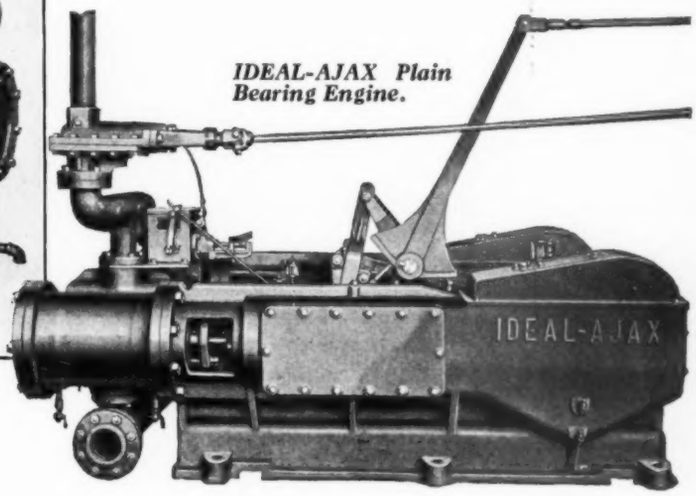
THE A. H. Neilson Mfg. Co. of Tulsa has recently introduced to the market the new improved Wedglock sucker rod hook shown in the accompanying picture. Some of the principal features of this hook are: The locking

mechanism in the latch and handle which prevents unlocking of the latch except by pressure on the latch lever on rear of hook. It is also provided with an enclosed grease-packed bearing which prevents the bearing from gathering grit and grime, and always allows free swiveling.

AJAX ENGINES MAKE GOOD RECORDS



AJAX 13 x 14 Plain Bearing Semi-Enclosed Engine.



IDEAL-AJAX Plain Bearing Engine.

Drilling Thompson No. 1 to 7,178 feet

THE Cromwell Oil & Gas Company abandoned this well located in Oklahoma as a dry hole. Ajax Engines can not guarantee oil but they can guarantee speed and low-cost drilling.

The two engines shown above are of the older type. Ask the National Supply man to tell you about the NEW IDEAL-AJAX 12x12 Twin with Roller Bearings and extra heavy Steam Separator.

AJAX

DRILLING ENGINES

Made by AJAX IRON WORKS, *Corry, Pa.*

DISTRIBUTED BY

THE NATIONAL SUPPLY COMPANIES

NSCO

OIL FIELD

When writing AJAX IRON WORKS *please mention The Petroleum Engineer*

Cooper-Bessemer Folder

THE Cooper-Bessemer Corporation, Mt. Vernon, Ohio, is the distributor of a very elaborate folder describing gas and oil engines manufactured and distributed by them. The folder has a two-fold value. First, it shows a complete line of gas and oil engines and gas engine-driven compressors built by one company for oil and gas field service. Second, the illustrations and condensed information make it a handy reference piece for filing. An outstanding feature of the folder is the condensed form in which it is written; the introduction can be read in less than two minutes.

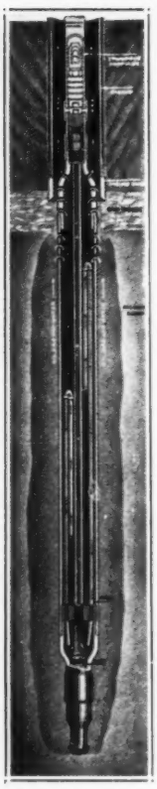
Moon Has Distributed Bulletins

THE Moon Manufacturing Company, Chicago, Illinois, has distributed literature concerning some new lighting plants for the oil industry. These plants come in both the direct connected and the belted type. According to the manufacturers, this self-contained lighting plant is extremely rugged in construction, provided with plenty of surplus power and has many desirable features of flexibility. It can be equipped to operate on either gasoline or natural gas.

Arc Welding of Pipe Lines

THE Lincoln Electric Company of Cleveland, Ohio, has distributed an exceptionally interesting piece of literature entitled, "Arc Welding of Pipe Lines," which deals with the application of electric welding process to pipe line construction. The booklet was written by J. F. Lincoln, president of the company, and is exceptionally well illustrated, giving photographs of pipe lines in all sections of the oil country.

New Device Is Patented to Prevent Cut Oil



THE Miller Combination Bailer and Pump Company, of Sapulpa, Oklahoma, is manufacturing a new device known as the Chancellor Separator, which is designed to separate the gas, sand and water from the oil at the bottom of the well. It is the result of several years' experimenting with various types of gas anchors by practical oil field superintendents. This new device is a positive gas anchor which is easily shown by the accompanying illustration, and is used below the working barrel at the bottom of the hole. The Chancellor separator prevents cut oil by keeping the gas out of the tubing and pumping the water separate from the oil by use of the perpetual syphon tubes. First a head of water, then a head of oil is pumped through the tubing, keeping worn barrel and cut cups from emulsifying oil and water. This eliminates the treating of oil. Sand troubles are eliminated, as it has two sand traps, as shown in the illustration, which settle out the sand. When the traps are filled with sand they can be flushed clean by pulling lower valve which has no gas anchor attached. More fluid can be pumped because there is always a full one-inch stream to the lower valve, thus making it practical to use oversize valves. The tubing is always full of fluid which prevents paraffined tubing, saves stuffing box rubbers, polish rods, and all other pumping equipment.

McCune Organizes New Specialties Co.

L. E. McCUNE, formerly manager of mechanical rubber sales of the Goodrich Rubber Co. at Los Angeles, has organized the Continental Machinery and Supply Co., with offices at 628 Subway Terminal Building.

The new company will handle a general line of oil well specialties, the principal items of which at present are a new type of piston for slush pumps and a new belt dressing, which carries the trade name of Castro because of its principal ingredient, castor oil. Other vegetable compounds make this belt dressing into a paste for convenient use in the field. The company will be incorporated, with L. E. McCune as president.

Byron Jackson Co. Holds Important Sales Conference

A CONFERENCE of all sales representatives of the Byron Jackson Co., oil tool division, was held in Los Angeles from November 4 to 12, inclusive.

The conference opened Monday, November 4, with the arrival of salesmen and field men from all the company branches in the Mid-Continent and Pacific Coast oil fields. After registering at the general offices of the company on East Slauson Avenue, the men spent the remainder of the first day visiting the Slauson Avenue and Vernon Avenue plants, getting first-hand information on manufacturing procedure and new products.

LEAVING Los Angeles the middle of November, J. C. Ballagh, secretary of Patterson-Ballagh Corporation, manufacturers of Bettis Protectors, is in the East, his itinerary including New York City, where he conferred with his corporation officials. He later attended the A. P. I. convention in Chicago. Returning to his Los Angeles office, he will stop en route in Tulsa, Houston and other points to visit various oil fields. Part of the trip will be made by airplane. Mrs. Ballagh will accompany him.

Engineers Everywhere

Show Their Confidence in Shaffer Equipment!

Photo Shows Five-Thousand-Pound Cellar Set-up for Kettleman Hills

The assembly is 100% Shaffer design and manufacture, and consists of high-pressure mud-cross, flanged to casing, a Control Gate with complete shut-off rams (replacing old-style drilling valve), then a Control Gate to close round drill pipe—and for additional protection and convenience, the famous Warren Control Head, which is the last word in improved packing assembly type blow-out preventors, with overflow connection and flanged Christmas-tree cap.

for
modern deep holes
heavy casing strings

and
extreme pressures
they are demanding
the latest and best—

including
Shaffer Control Gates
Warren Control Heads
Shaffer Cellar Fittings
Olinda Casing Heads
Shaffer Mud Crosses
Adjustable Flow Beans
Shaffer Kelly Cocks

and
other hi-pressure and safety-first Shaffer equipment

◆

Made by

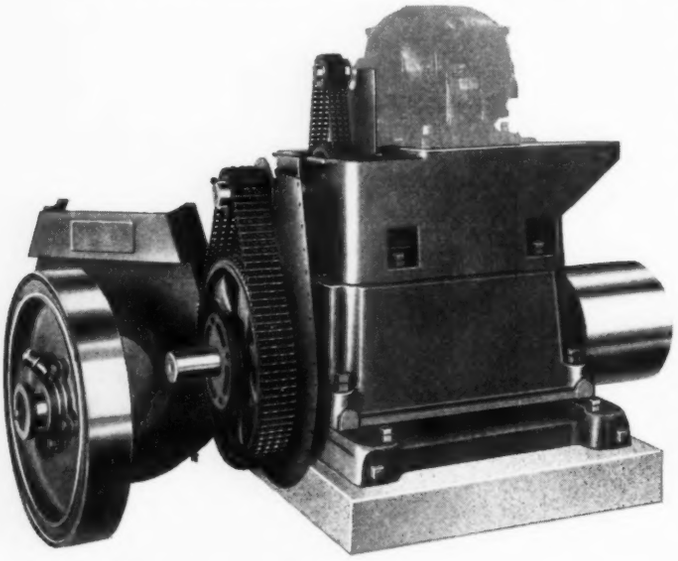
SHAFFER
TOOL WORKS

BREA CALIFORNIA

IF YOU CAN'T GET TO BREA TO SEE US MAKE 'EM AND TEST 'EM—WRITE

New O. C. S. Equipment

THE O. C. S. Mfg. Company is announcing a new piece of equipment known as their auxiliary diamond Timken reduction unit, which consists of a similar, but smaller single reduction unit and is adaptable to the diamond Timken reduction unit, of which so many are in operation in all the electrically equipped oil fields. The diamond T re-



duction unit was built adaptable to standard oil well motors of various makes. The auxiliary diamond T unit is adapted to replace the oil well motor on the diamond T unit and is designed to accommodate constant speed motors of 900 or 1,200 r. p. m. and up to 40 h.p. capacity. The outfit is equipped with Timken bearings and diamond roller chain and is unique in the fact that one splash system lubricates both bearings and chain.

The outfit is adaptable to all O. C. S. units now in the field, so that higher speed constant speed motors may be used as wells become lighter and pulling operations less frequent so that other means for servicing the well may be conveniently and economically used. Detailed information is furnished in bulletin 31, which may be had upon request to the O. C. S. Mfg. Company at Coffeyville, Kansas.

Grant Oil Tool

DUE to the continual increase in the use of the Grant Rotary Underreamer in the California Midway fields, the Grant Oil Tool Company has found it necessary to appoint a permanent representative to this area. L. O. Myers has been selected and will render a thoroughly experienced sales and counsel service to operators in Taft, Bakersfield, Maricopa and vicinity. He is an "old hand" in the drilling and production end of the oil industry and is personally familiar with the various problems for which underreaming is the solution.

JOSEPH REID GAS ENGINE COMPANY has recently issued five new catalogs describing various products of their manufacture. These are as follows: No. 46—Type B 45 HP and 16x21-inch Four-Cycle Gas Engines; No. 47—Fulton Type Look Boxes; No. 48A—No. 55 Heavy Duty Reverse Rigs; No. 49—Pressure Oiling System for Type B Enclosed Two-Cycle Gas Engines; No. 50—Type B Four-Cycle, 30, 35 and 40 HP Gas Engines.

Copies of any or all of these catalogs will be gladly furnished upon request.

THREE Important Belt-Saving, Power-Saving Units for the Oil Field are described in a folder which the Happy Belting Company has mailed to the trade—the Happy Belting Tightener for beam wells, the Happy Automatic Belt Idler for band wheel powers and the U. G. Automatic Belt Contractor for short center drives. The tightener for beam wells is said to permit the use for endless belts, eliminating clamp trouble. The Automatic Belt Idler for powers is said to eliminate all guesswork in applying tension to the slack side of the belt. Any change in length of the belt because of change in load or shrinkage due to change in weather is automatically cared for and a predetermined tension in the belt is never exceeded. The automatic belt contractor is instrumental in saving much floor space by permitting closer setup of motor and machinery.

National Transit Catalog

NATIONAL TRANSIT PUMP & MACHINE COMPANY, Oil City, Pa., has mailed to the trade an exceptionally well printed and perfectly illustrated catalog on Transit Gas Engine Compressors. This catalog treats exclusively the design and construction of the new type equipment which National Transit is producing, each separate part of the compressor being adequately described and illustrated. Several cross sections of the mechanism are shown.

Emsco Rotary Equipment Described

THE Emsco Derrick & Equipment Company, Los Angeles, California, has mailed out Bulletin Number 29, containing a great deal of information about the company's line of couplings, drill collars, fishtail bits and substitutes. Unlimited data on the size and specification of these products is printed. The company also has issued a catalog on the Emsco Hi-Ten Derrick, which is manufactured to A. P. I. specifications.

Sotco Hydraulic Knuckle Literature

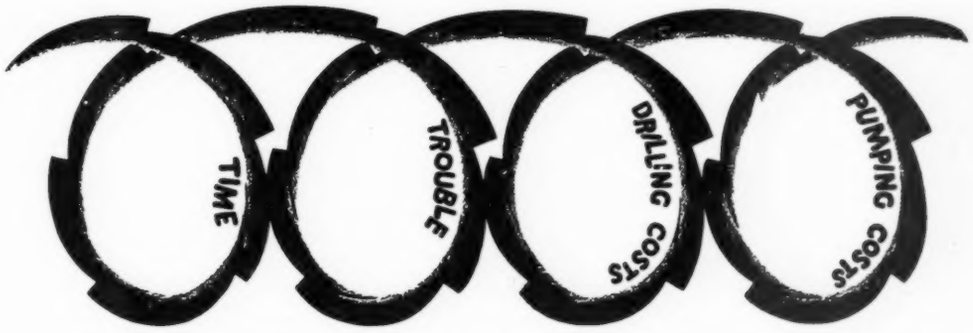
DIRECT-MAIL matter pertaining to several items of rotary fishing tools manufactured by the Specialty Oil Tools Company of Los Angeles, and distributed by the Lucey Products Corporation of Tulsa, Okla., has been mailed to drilling contractors and company superintendents. The literature describes several items, including hydraulic knuckle or dog-leg.

Pierce Tubing Tongs

PIERCE Tubing Tongs are amply described in a folder distributed by Skinner Bros. Belting Company, Tulsa, Okla. It is claimed that the tongs will not crush or dent the tubing, that they grip the tubing equally in three places and that every part is made of high-grade steel, all parts being replaceable, and that they will ratchet on pipe without falling off.

4 REVOLUTIONS

overturning



WITH ONE CRANK

Pat. Applied For

The New
K.M.CO. SPECIAL TAPER-HOLE CRANK *with* KEYED-QUICK-CHANGE TAPERED WRIST PIN

Four long-reigning bugaboos are overturned by the new KM CO Crank. This equipment enables the operator to make a quick and easy change of the wrist pin in the crank holes, according to the length of stroke desired in varying drilling and pumping conditions. Time and Trouble are eliminated and Drilling and Pumping Costs are reduced by this crank's revolutionary features.

No Nut or Threaded End

To change the Wrist Pin from one Crank Hole to another it is necessary only to tap lightly on the key that holds the Wrist Pin in place and the Wrist Pin can then be easily removed from the Tapered Crank Hole. No nut or threaded end is necessary to hold the tapered wrist pin in position, as it is drawn tight in the Tapered Crank Hole by a light blow on the Key, which makes a metal-to-metal contact. The Key is driven into a groove in the Crank, which prevents the turning of the Wrist Pin, thus eliminating any wear in the Crank Hole or the surface of the Wrist Pin and insuring a perfect contact and tight fit at all times. This equipment is furnished assembled on 6″ A.P.I. Standard Shaft, and can be ordered now through Kirk-Morrow Warehouses and Sales Offices.

THE KIRK M ORROW IRON WORKS IOLA KANS. CO

PRODUCTS

Steel Tankage, Tank Fittings, Refinery Equipment, Steel Plate Construction, Steel Derricks, Rig Irons, Bull Wheels, Calf Wheels, Band Wheels, Crown Blocks, Tug Wheels, Sand Reels.

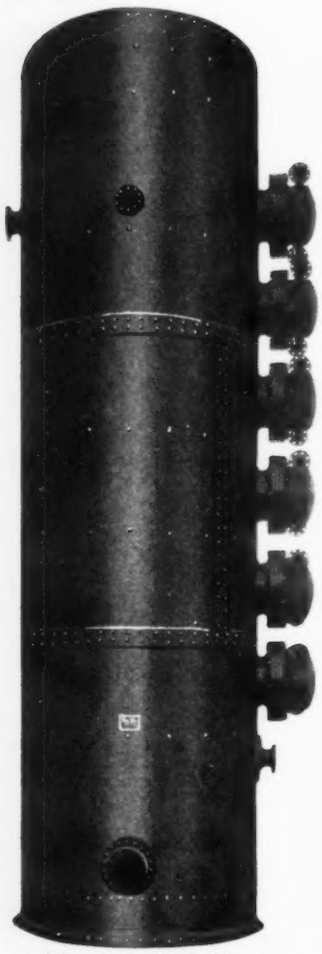
THE KIRK-MORROW IRON WORKS COMPANY

Sales Offices: Hunt Bldg., Tulsa, Oklahoma; Magnolia Bldg., Dallas, Texas; Central Bldg., Wichita, Kansas

When writing THE KIRK-MORROW IRON WORKS COMPANY *please mention The Petroleum Engineer*

The New Tulsa Type Evaporator

THE latest addition to the Tulsa Type line of gasoline plant equipment is the new Tulsa Type Evaporator with built-in heating elements. This evaporator is covered by patents No. 1695192 and No. 1637947, with other patents pending.



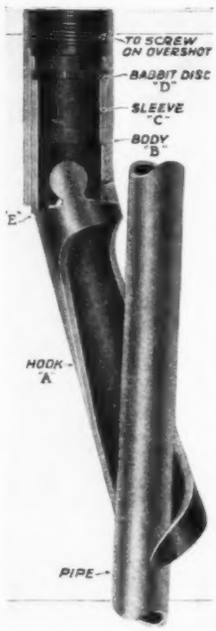
The outstanding feature of this new piece of equipment is the built-in heating elements which do away with the old method of heating on the trays for evaporation. The bottom tray, which determines the efficiency of an evaporator, is hottest, thereby increasing the efficiency of the heating elements due to greater M. T. D. It eliminates the necessity of insulating preheaters and the use of a vent tank before preheaters, thereby saving the radiation losses that would occur from these pieces of equipment.

In addition, the oil passes to the exchangers at a higher temperature, thereby increasing evaporation in exchangers themselves, which in turn increases their efficiency due to this evaporation establishing a greater M. T. D.

The result is a saving of open steam of not less than twenty per cent (20%). A saving of ten per cent (10%) due to reduced radiation losses and a saving of in excess of ten per cent (10%) due to increased heat exchanger efficiency, thereby making a total of thirty per cent (30%) saving in steam consumption when operated at the same pressure. Or the equipment can be operated at a higher pressure, thereby increasing the efficiency of the condensing coils, resulting in a large saving on this equipment and also on the recompressor load.

SEVERAL promotions are to be made in the organization of the Merco Nordstrom Valve Company, effective January 1, by order of the Board of Directors. Comfort E. Brown, Eastern divisional manager, will become vice-president in charge of sales, continuing his headquarters in New York City. C. C. Evernham, Western divisional manager, becomes purchasing agent in charge of all purchases and will be stationed in San Francisco. E. D. Rogers, Southern divisional manager, will become general sales manager and will make his headquarters in the San Francisco office.

THE Campbell Engineering Co., Short Hills, N. J., announces that important changes have been made. The following representatives, recently appointed, are the only ones now representing them: Geo. B. Allan & Co., 327 Exchange National Bank Bldg., Tulsa, Okla.; Geo. B. Allan & Co., 405 N. Texas Bldg., Dallas, Texas; L. E. Pollard, 205 Oliver Bldg., Pittsburgh, Pa.; Smiley Equipment Co., 202 Carmen Bldg., Kansas City, Mo.



THE Brauer Machine & Supply Company of Seminole and Oklahoma City has published some descriptive literature, giving data on the Brauer Hydraulic Wall Hook, which is used in fishing jobs where the pipe is leaning over into the wall or where the top of the fish cannot be reached with an ordinary tool.

IMPROVED Spartan Products for Oil Field Drilling is the title of the catalog issued by the Spartan Steel Company of Compton, Calif. This catalog contains some very interesting information concerning the metallurgy of drilling tools and shows several illustrations of the tools manufactured by this concern. Particular attention is given in the catalog to hard-facing drilling equipment.

BULLETIN 6000, Quimby Pump Company, Newark, New Jersey, describes and illustrates the use of Quimby screw pumps and their use for general oil refinery service, including hot oil service and the handling of refinery acid sludge.

Victaulic Co. Has New Distributor

W. B. DAMSEL, vice-president of the Victaulic Co. of America, with offices at 26 Broadway, New York, has just returned to the east after a business trip to California.

Negotiations have been completed whereby the Ducommun Corp. of Los Angeles and San Francisco will distribute Victaulic couplings exclusively in the territory from Salt Lake City west, including Washington, Oregon and Idaho.

SLURRY and Sludge Pumps, Bulletin 135, by the Morris Machine Works, Baldwinsville, N. Y., is a well illustrated bulletin, showing various types of pumps for handling liquids or mixtures of highly abrasive solids in suspension and acid slurry.

The General Electric Company has distributed Bulletin GEA-1172, which treats with super-synchronous motors for industrial installations.

R. R. Weidman

REPRESENTING Black, Sivalls & Bryson, of Bartlesville, Oklahoma, on the sale of bolted steel tanks, and the American Tank Company, of Oklahoma City, Oklahoma, on American separators, as well as derrick sales for Lee C. Moore & Company, of Pittsburgh, Pa., R. R. Weidman sailed November 20 for Puerto, Colombia, where he will remain until the close of the year, going then to Maracaibo, Venezuela, where his headquarters will be. Mr. Weidman will maintain close contact with operating conditions in the South American fields.

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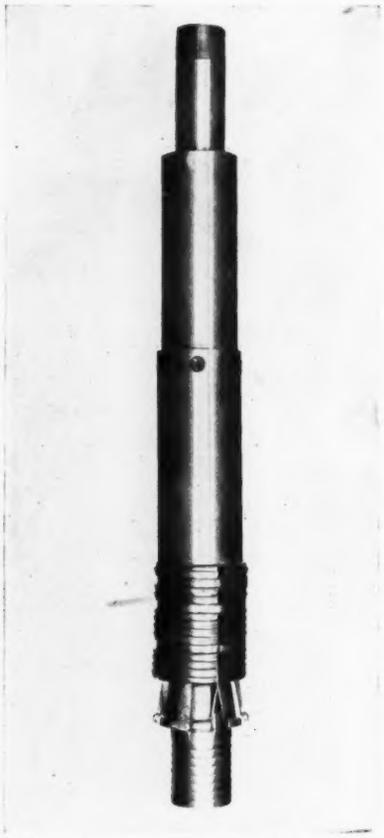
A Tubing Catcher by Ideco



PICTURED herewith is a tubing catcher of particular interest to every oil operator and remarkable for its simplicity of construction. It is said to be foolproof. The Ideco tubing catcher while positive in action, runs freely in the proper size casing, is not tripped by parafine or crooked holes and can be run in as fast as desired. In case of a break in the tubing either above or below the catcher, it will set within a drop of approximately two inches. Furthermore, it will automatically set when the tubing strikes the bottom of the hole while being run in. Operators can tell definitely when the catcher takes hold.

The slips are prevented from overexpanding and damaging the casing when set. The teeth, unusually large, cut in quicker and hold better than fine teeth and are not easily filled with scale and dirt. They cannot ride the casing nor become dull while being run. Slips set with a full bearing against the casing wall.

Sufficient clearance is provided between the tubing catcher and casing to permit free passage of gas and oil. Provision is made so that the tubing can be easily drained and pulled dry.

Although the Ideco tubing catcher is a comparatively new device, many installations have been in use for over 18 months and the numerous advantages of its use in deep wells have been conclusively demonstrated. It is manufactured by The International Derrick & Equipment Company and may be obtained through any of its branches.

One of the most interesting treatises on bit problems in rotary drilling is contained in the new booklet entitled "Hole", just issued by the Universal Engineering Company, 2369 East Fifty-first street, Los Angeles. An extensive study was made of the problems that affect drilling bits of all makes, to the end of increasing efficiency and getting more hole.

Actions of bits in various formations is given with interesting charts. Problems of the crooked hole, twist-offs, etc., are illustrated and the merits of the Zublin bit in meeting these conditions are pointed out in detail.

This new booklet, in addition to giving the mechanical and other details of the Zublin bit, may be of help to the engineers, executives and operators. Copies may be had by writing the Universal Engineering Company.

Lucey Changes Address

Lucey Products Corporation has moved its Oklahoma City store from 2604 South Harvey Street to 1205 East G Street.

General Electric Sales

GENERAL ELECTRIC COMPANY sales billed during the first nine months of 1929, announced by President Gerard Swope, amounted to $301,812,808.55, compared with $242,676,762.07 for the corresponding period last year, an increase of 24 per cent. Profit available for dividends on common stock for the first nine months of 1929 was $47,965,831.71, compared with $36,910,649.96 for the corresponding nine months last year.

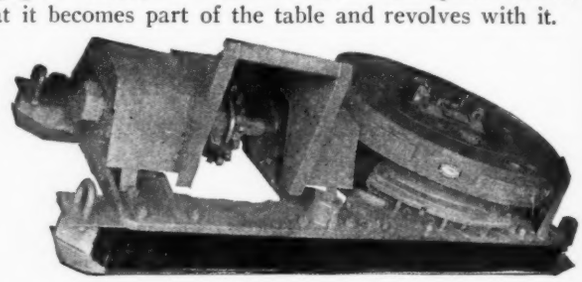
Metallurgical Uses of Natural Gas

THE probability that the development of metallurgical uses for natural gas may stimulate the growth of chemical and metallurgical industries on the Pacific Coast is suggested by the United States Bureau of Mines, Department of Commerce. The Pacific Experiment Station of the Bureau of Mines, located at Berkeley, California, has recently had many requests for information concerning possible metallurgical uses for natural gas or methane. The thermodynamic investigations of the properties of metallurgically important materials being conducted at that station have been particularly useful in enabling such inquiries to be met in a helpful manner.

Ideco Introduces New Rotary

THE Boykin Greyhound Division of The International Derrick & Equipment Company, familiarly known as "Ideco", has just introduced a new 27-inch Superior make and break rotary, having greater speed, smoother operation and roller bearings.

Being of the Boykin make and break type it is quickly changed from a make-up position to the break-out position by lifting the spider by the cat line until the teeth are disengaged. Slides are then moved out and spider lowered so that it becomes part of the table and revolves with it.



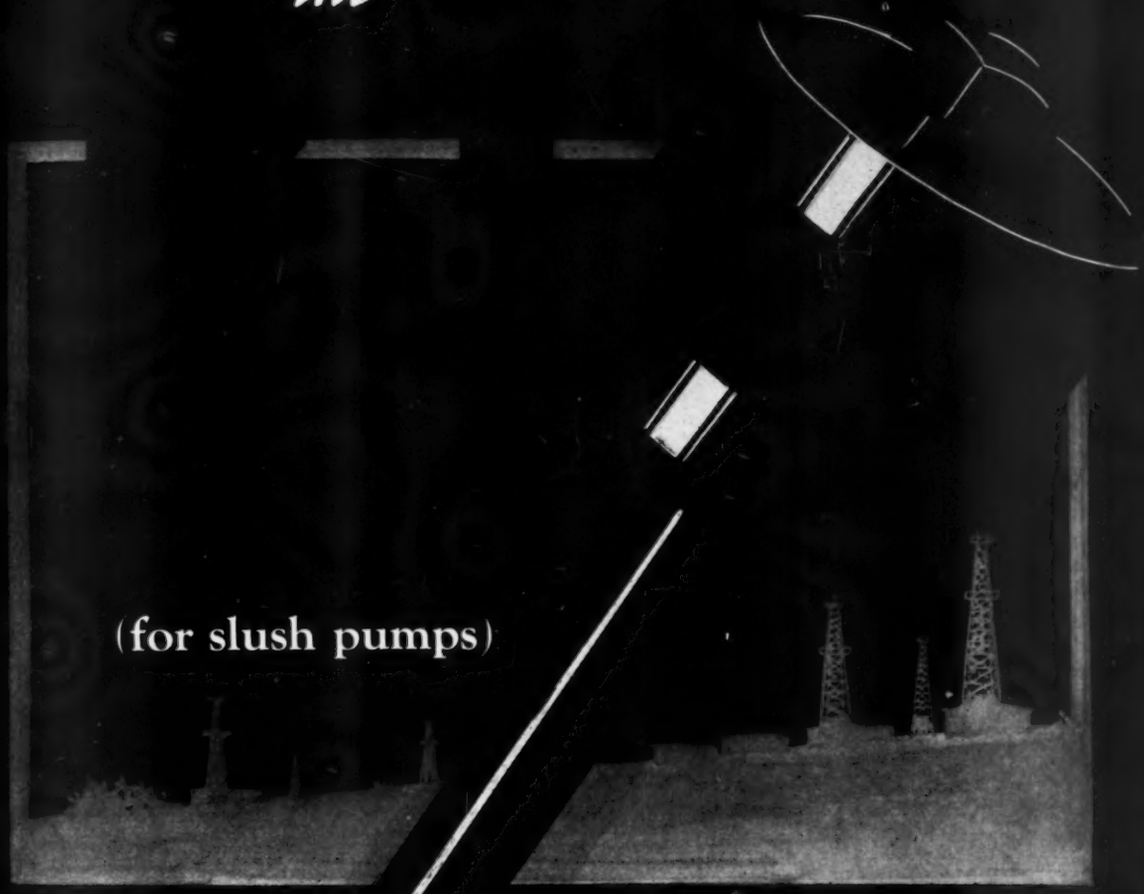
The main table, spider, table and bearing box base, pinion and sprocket are made of chrome nickel steel, thus assuring long life to these vital parts. The table revolves on pack hardened cones or extra hard steel ball bearings, either of which is optional with the purchaser. The 3 15/16 inch pinion shaft rotates on 4-inch Hyatt roller bearings. The steel sprocket on this shaft is adjustable 12 inches, thus assuring proper alignment with the draw works.

The main table has a diameter of 57 inches and is capable of receiving a 27-inch fish-tail or rock bit. The entire rotary is mounted on 8-inch H beam steel skids 10 feet in length with U bolts at each end to facilitate handling.

The bearing boxes, table hold-down, and cone races are provided with connections for Alemite lubrication. The cone races are entirely encased to keep out mud and grit. A heavy gauged steel sheeting hood completely covers the bearing boxes and serves as a guard for the pinion sprocket. These rotaries can be equipped with the famous Boykin patented grief stem drive.

A new pamphlet thoroughly describing this new four-speed reduction gear draw works will be mailed upon request to The International Derrick & Equipment Company at one of their main offices in Columbus, Ohio, or Los Angeles, Calif., or to any of their sales offices.

the



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Stabilization of Knock Rating, Gums, and Color of Gasoline by Chemicial Inhibitors

By GUSTAV EGLOFF, W. F. FARAGHER and J. C MORRELL*

Universal Oil Products Company, Research Laboratories, Chicago, Illinois

ONE of the urgent problems of the refining industry is the stabilization of gasoline with respect to knock rating, formation of gum, and color. The development of color and the formation of gum in stored gasoline have been known for some time. The problem of the depreciation of the knock rating of some cracked gasolines has arisen recently. Cases are known in which gasolines have dropped from a benzol equivalency of forty per cent to minus thirteen per cent after a month of commercial storage. Highly cracked gasolines depreciate particularly rapidly in regard to the knock rating, gum, and color. Such gasolines have been found to deteriorate markedly in a few days.

The extent to which stored gasoline depreciates depends upon many factors, among which are oxidation by air, light, and heat. Cracked gasolines are inherently more susceptible to depreciation than the straight-run products, owing to the difference in the amount and kind of unsaturated hydrocarbons present. However, changes in color, amount of gum, and knock rating of most properly refined cracked gasolines are so small as to cause no material difficulty. Although the field has not been investigated thoroughly, the character of the charging stock and the conditions under which it is cracked are probably the factors that determine the stability of the refined gasoline.

The formation of undesirable gums or resins is not limited to the petroleum industry. Industries dealing with turpentine, aldehydes, alcohols made from cracked gases, vegetable oils, and rubber are also confronted with the formation of gummy resinous substnces in their products. Oxidation by air seems to be involved in all these changes.

This paper presents the results of a study of the changes of knock rating, content of gum, and color which cracked gasoline undergoes and of methods of stabilization.

Chemical inhibitors have been found which substantially prevent the lowering of knock rating, stabilize color, and check gum formation during storage. Processes have been devised also for restoring the knock rating of deteriorated gasoline to its original benzol value.

Changes in Knock Rating of Stored Cracked Gasoline

A number of cracked gasolines which had been in storage for periods varying from six months to nearly two years were retested for knock rating. Several samples showed no change, but others had dropped by as much as sixty-five per cent of the original benzol equivalent.

Table I shows the change in knock rating of a number of these cracked gasolines.

*Presented before Group Meeting on Refinery Technology, American Petroleum Institute, Chicago, Illinois, December 5, 1929.

Chemical Inhibitors to Stabilize Knock Rating of Gasolines

When some gasolines are stored for relatively long periods of time, oxidation products are formed, some of which are gum or gum-forming substances. The oxidized products consist in part of peroxides, acids, aldehydes, and ketones. Coincident with their formation there is a drop in knock rating of some cracked gasoline during storage. Aniline, hydroquinone, naphthalene and anthracene have been found in this investigation to inhibit the changes that decrease the knock rating during storage. The same substances are also effective in preventing a reduction in knock rating when the gasolines containing them are subjected to the accelerated oxidation test for gums proposed by Voorhees and Eisinger,[1] namely, heating the gasoline to a temperature of 212° F. in an atmosphere of oxygen for a period of 5 hours.

In a set of experiments using a Pennsylvania cracked gasoline, the accelerated oxidation test lowered the benzol equivalent from forty to twenty-nine per cent. The addition of 0.1 per cent by weight of aniline or hydroquinone to the cracked gasoline preserved the knock rating when the gasoline was subjected to the same accelerated oxidation test condition. Naphthalene and anthracene also acted as inhibitors but to a lesser degree than aniline and hydroquinone.

In another set of experiments using a Mid-Continent cracked gasoline, aniline gave poor stability while the other inhibitors mentioned gave good results.

The following data show the detailed experimental results:

The following data cover a Mid-Continent cracked gasoline of 410° F. end point which was stabilized by chemical inhibitors, as far as its knock rating was concerned.

TABLE 3

	Color Before Oxidation	Color After Oxidation	Gums mg. per 100 cc. Copper Dish	Benzol Equivalent Per Cent (Delco Motor Test)
Gasoline Alone—				
Before Oxidation	20		25	32
After Oxidation		Yellow	331	15
With Inhibitors (0.1 per cent by wt. of gasoline)—				
Aniline	Yellow	Yellow	9	36
Dimethylaniline	16	"	22	30
Diethylamine	16	"	337	30
Hydroquinone	20	"	11	31
Anthracene	18	"	60	30

Aniline is a stabilizer and also has anti-knock properties of its own when added to gasoline. The increase of four per cent of benzol is the calculated amount for the quantity of aniline added.

[1]A. P. I. Refinery Technology Section II, 169 (1928).

TABLE I
KNOCK RATING OF CRACKED GASOLINES BEFORE AND AFTER STORAGE

Months in Storage	Metal Container (tinned iron) Condition After Storage	Cracked Gasoline Source	Cracked Gasoline A. P. I. Gr.	Cracked Gasoline I. B. P. °F	Cracked Gasoline E. P. °F	Benzol Equivalent Before Stor. Delco Motor Test	Benzol Equivalent After Stor. Delco Motor Test
6	Clean	Smackover	58.4	100	419	45	46
11	Red Gum Deposit	South Field, Arkansas	62.3	110	367	35	15
11	Slight Deposit	South Field, Arkansas	60.3	103	388	32	30
12	Clean	Mid-Continent	59.8	113	389	37	38
12	Clean	Mid-Continent	59.6	110	391	37	34
12	Clean	Mid-Continent	60.1	103	391	35	20
12	Clean	Mid-Continent	59.2	106	402	37	12
23	Clean	Mid-Continent	63.9	112	377	40	31
23	Clean	Mid-Continent	58.4	104	422	42	32
23	Clean	Mid-Continent	61.0	106	400	45	36

TABLE 2

CHEMICAL INHIBITORS AND KNOCK RATING
PENNSYLVANIA CRACKED GASOLINE

	Original Gaso.	After Oxidation	Aniline	Hydroquinone	Urea	Phenol	Naphthalene	Anthracene
I. B. P. °F	94	114	112	105	130	114	108	12
E. P. °F	427	434	429	430	431	432	434	44
Color Saybolt	24	—16	—16	Yellow	—5	Yellow	0	....
Mgs. Gum Copper Dish	19	220	55	16	56	139	241	7
Mgs. Gum Glass Dish	3	55	5	6	14	36	36	2
			Hydrocarbons[1]					
Per Cent—								
Unsaturates	24.0	23.0	.....	.....	.....	.....	.....	....
Aromatics	22.9	22.5	.....	.....	.....	.....	.....	....
Naphthenes	9.3	10.1	.....	.....	.....	.....	.....	....
Paraffins	43.8	44.4	.....	.....	.....	.....	.....	....
			Delco Motor Test					
Benzol Equivalent Per Cent	40	29	39	40	34	31	35	34
			MIDCONTINENT CRACKED GASOLINE					
I. B. P. °F	103	114	106	110	108	107	108	118
E. P. °F	320	335	319	313	301	302	313	312
Color Saybolt	30	7	—16	13	26	16	28	28
Mgs. Gum Copper Dish	68	475	389	26	198	131	126	73
Mgs. Gum Glass Dish	1	136	29	3	13	16	5	3
			Hydrocarbons					
Per Cent—								
Unsaturates	36.2	41.1	.....	.....	.....	.....	.....	....
Aromatics	12.0	7.8	.....	.....	.....	.....	.....	....
Naphthenes	11.9	11.7	.....	.....	.....	.....	.....	....
Paraffins	39.9	39.4	.....	.....	.....	.....	.....	....
			Delco Motor Test					
Benzol Equivalent Per Cent	56	37	34	52	40	47	47	47

[1]Egloff and Morrell, J. Ind. Eng. Chem., 18, 354 (1926). This method was used throughout.

A California cracked gasoline showed marked stability in regard to knock rating when subjected to the accelerated oxidation test. This would indicate that the oxidation products in this gasoline did not affect its knock rating. Although the gum was increased by oxidation, the benzol equivalent was decreased only from fifty-five to fifty-one per cent, and a Pennsylvania cracked gasoline subjected to the same conditions of oxidation depreciated in benzol value from forty per cent to twenty-nine per cent, while a Mid-Continent motor fuel dropped from fifty-six per cent to thirty-seven per cent. This difference may be due to the nitrogen compounds present in the California cracked gasoline which act as antioxidants or inhibitors.

TABLE 4

ACCELERATED OXIDATION TREATMENT OF CALIFORNIA CRACKED GASOLINE

	Original Gasoline	After Oxidation
I. B. P.—End Point °F	92°—428°	125°—435°
Color, Saybolt	30	Yellow
Mgs. Gum (copper dish)	11	77
Mgs. Gum (glass dish)	Trace	32
	Hydrocarbons, in Per Cent	
Unsaturates	19.4	23.4
Aromatics	25.2	24.1
Naphthenes	13.4	12.4
Paraffins	42.0	40.1
	Delco Motor Test	
Benzol Equivalent, Per Cent	55	51

Table 5 summarizes the changes in knock rating of four cracked gasolines subjected to the accelerated oxidation test.

TABLE 5

Gasoline	I. B. P.	End Point	Benzol Equivalent, Per Cent Delco Motor Test Original Gasoline	Gasoline After Oxidation
California	92	428	55	51
Pennsylvania	94	427	40	29
Midcontinent	103	320	56	37
Midcontinent	107	411	36	21

From a study of the data there appears to be a relationship between the depreciation in knock rating and the increase in gum formation. Generally speaking those materials which inhibit gum formation also check depreciation in knock rating, although there are some exceptions to this generalization, e. g., diethylemine will inhibit the depreciation of knock rating under the test conditions but does not prevent increase in gum. On the contrary it appears to promote gum formation. Other substances which act as inhibitors in preventing knock depreciation fail to prevent increase in gum.

The formation of easily oxidizable gum-forming materials is accompanied in some cases by a depreciation in knock rating. It cannot be generalized, however, that the two phenomena are directly related because the addition of inhibitors may prevent decrease in knock rating without preventing gum formation.

Gum in Cracked Gasoline

The formation of gums in highly cracked gasolines was noted by Hall[1] in 1915. He recognized that it was an air oxidation process and unless the gasoline was properly refined would "clog and stick up the valves of any engine in which it may be used." With some cracked gasolines gum formation is still a problem from a theoretical and a practical viewpoint.

Moureu and Dufraisse[2] have made an extensive study of the effect of anti-oxidants in preventing the oxidation of sensitive materials such as furfural, acrolein, styrol, linseed oil, which ordinarily under oxidizing conditions would develop color or form gum-like substances. These authors have found that a mere trace of pyrogallol will prevent the oxidation of acrylic aldehyde for example even in an atmosphere of oxygen.

The National Benzol Association of England[3] has reported upon the gum or resin formation in benzol motor fuels. They have found that tricresol acts as an inhibitor of the formation of gum. Some experiments indicate that a chemical inhibitor in a benzol motor fuel may act as an accelerator in some containers. Gum formation is also dependent upon the percentage of inhibitor added; a small quantity may act as an inhibitor of gum and a larger quantity as an accelerator.

Water has some influence on gum formation, but quantitative data are lacking.[4] Water may act either as a gum inhibitor or accelerator. Hence, it is extremely important that in all studies of gum formation in motor fuels the quantity of inhibitor, presence of water, type of container, oxidizing agent, temperature or light effects should be reported.

When cracked gasolines are subjected to oxidation by air or oxygen, the formation of gum increases. Of the gasoline used in these tests those from California and Pennsylvania were found to be more resistant to gum formation than the gasolines from the Mid-Continent. The data are shown in Table 6.

TABLE 6

Cracked Gasoline	Mgs. Gum Copper Dish Method	Mgs. Gum Glass Dish Method
California Before Oxidation	11	Trace
" After "	77	32
Pennsylvania Before Oxidation	19	3
" After "	220	55
Mid-Continent Before Oxidation	9	2
" After "	619	97
Mid-Continent Before Oxidation	68	1
" After "	475	136

A series of chemicals were tested as inhibitors of gum formation during exposure to sunlight in the presence of oxygen. The inhibitors were added to the gasoline in weights of 0.1 grams per 100 c.c. Naphthalene, urea, pyrene, phthalic anhydride, and carbazole were effective in a Mid-Continent cracked gasoline.

This cracked gasoline had a gravity of 58° A. P. I., an

[1]J. Inst. Petr. Tech., Page 147, 1915.
[2]Moureu and Dufraisse, Chem. Rev. 3, July (1926).
[3]Natl. Benzol Assoc. of England, Report of Research Com., p. 61 (1929).
[4]Natl. Benzol Assoc. of England Report of Research Com., p. 67 (1929).

initial boiling point of 110° F., and an end point of 437° F.

Table 7 shows the effect of chemical inhibitors upon gum formation when the gasoline was exposed to sunlight for twenty-four hours.

The gum in the original gasoline was six milligrams per 100 cubic centimeters, and after exposure to sunlight, fifteen milligrams.

TABLE 7

Chemical Inhibitor	Mgs. Gum Glass Dish Method
Naphthalene	2
Pyrene	2
Phthalic Anhydride	4
Urea*	6
60% Carbazole	6

*Urea in another gasoline increased the gum; the gasoline after exposure to sunlight showed six milligrams and the gasoline plus urea, seventy-eight milligrams. This behavior emphasizes the fact that a chemical will not necessarily act as an inhibitor under all conditions.

Several cracked gasolines were subjected to the accelerated oxidation tests with and without the use of chemical inhibitors. It was found that aniline, dimethyl aniline, urea, hydroquinone, and anthracene were effective in checking gum formation. The tabulated data present the experimental results obtained:

TABLE 8

PENNSYLVANIA CRACKED GASOLINE
(I. B. P. 94°F.—427°F. E. P.)

		Original Gasoline	After Oxidation	Inhibitors Aniline	Urea
Mgs. Gum, Copper Dish		19	220	55	16
" " Glass "		3	55	5	6

MID-CONTINENT CRACKED GASOLINE
(I. B. P. 103°F.—320°F. E. P.)

			Hydro-quinone	Anthra-cene
Mgs. Gum, Copper Dish	68	475	26	73
" " Glass "	1	136	3.2	2.5

MID-CONTINENT CRACKED GASOLINE
(I. B. P. 110°F.—410°F. E. P.)

			Aniline	Dimethyl-aniline	Hydro-quinone
Mgs. Gum, Copper Dish	25	331	9	22	11

Color Stability

Very little is known about the composition of the coloring matter in gasoline. It has been generally assumed to result from the chemical changes of the more highly unsaturated compounds. Factors favoring the formation of gum in cracked gasolines, such as light, heat and oxidizing agents usually cause the development of color.

The decomposition of acid esters in improperly refined gasoline, and the reaction products of sulfuric acid generated from the alkyl sulfuric acids are responsible sometimes for the color. Elementary sulfur generally causes discoloration of cracked gasoline.

Some gasolines are not color stable when they are subjected to sunlight or ultra-violet light; or are stored for a long time. A high summer temperature may develop color in a short time. A deep yellow, green, brown, pink, or wine red color develops, depending upon the gasoline. This color change may be prevented by small percentages of chemical inhibitors.

A gasoline produced from a Mid-Continent cracking stock, treated with three pounds of 66° Be. sulphuric acid per barrel, water washed, neutralized and distilled with fire and steam at a temperature of 350° F., was used in one series of color-stability tests. The gasoline had a gravity of 58° A. P. I., an initial boiling points of 110° F., and an end point of 437° F.

One hundred cubic centimeter samples of this gasoline, containing 0.1 gram of a number of chemicals, were exposed to twenty-four hours of sunlight. The changes in the color and the gum content were then determined. The data are shown;

TABLE 9

Color before exposure	22
Color after exposure (no stabilizer present)	17
Mgs. gum/100 cc. by glass dish method—	
Before exposure	6
After exposure	15

Stabilizer Used	Color after 24 Hrs. of Sunlight	Mgs. Gum/ 100 cc. Glass Dish Method
Gum Camphor	22	20
Phenanthrene	21	18
Urea	21	6
Pseudo-cumene	21	9
Acenaphthalene	21	9
Methyl Naphthalene	20	14
Anthracene	20	14
Naphthalene	20	2
Fluorene	20	11
Tetralin	19	13
Naphthol	19	14
Hydroquinone	19	12
Phthalic Anhydride	19	4
Phthalimide	17	7
60% Carbazole	15	6
Pyrene	10	2

In a second series of tests a gasoline with a color of 20 Saybolt made by treating a Mid-Continent pressure distillate with three pounds of 66° Be. sulfuric acid per barrel, water washing, neutralizing, and rerunning at a still temperature of 375° F., was treated with 0.1 per cent by weight of the inhibitors. The gasoline without a stabilizer dropped to a color of 12 Saybolt on exposure for eight hours in sunlight. The results with the inhibitors are as follows:

TABLE 10

Inhibitor	Color After Sunlight Exposure for 8 Hours
Pseudo-cumene	16
Methyl Naphthalene	16
Methyl Naphthalene	16
Fluorene (80—85% pure)	16
Pyrene	16
Acenaphthane	16

A third series of tests was made with a cracked Mid-Continent gasoline, the color of which was 18 Saybolt. This gasoline when exposed to sunlight for three days without the addition of an inhibitor dropped in color to 14 Saybolt. The results obtained by using 0.1 per cent of weight of various inhibitors are as follows:

TABLE 11

Inhibitor Added to Gasoline	Color After Sunlight Exposure for 3 Days
Tetralin	21
Urea	21
Phthalimide	19
Naphthalene	19
Camphor	19
Anthracene	18
Phenanthrene	18
Phthalic Anhydride	18
Naphthol	16
Carbazole	14

The color of another Mid-Continent cracked gasoline, with and without the addition of traces of naphthalene and anthracene, was determined before and after exposure to sunlight in an atmosphere of oxygen. The original color of the cracked gasoline before treatment was 30 Saybolt. The color dropped during the exposure to 22 Saybolt when no inhibitor was present. However, when the inhibitors were used the color fell only to 28 Saybolt.

It must be acknowledged that a given chemical inhibitor may be effective as a color stabilizing agent with one gasoline and not with another under the same conditions.

Regenerating or Restoring Anti-Knock Properties of Gasoline

A series of experiments was made to develop methods for restoring or regenerating the anti-knock properties of depreciated gasoline.

The first tests were made with refining agents and a Pennsylvania cracked gasoline having an original benzol equivalent of forty which had been depreciated in knock rating by the accelerated oxidation treatment to a value of twenty-nine per cent.

Another set of tests was made with a Mid-Continent cracked gasoline which had been depreciated by the same

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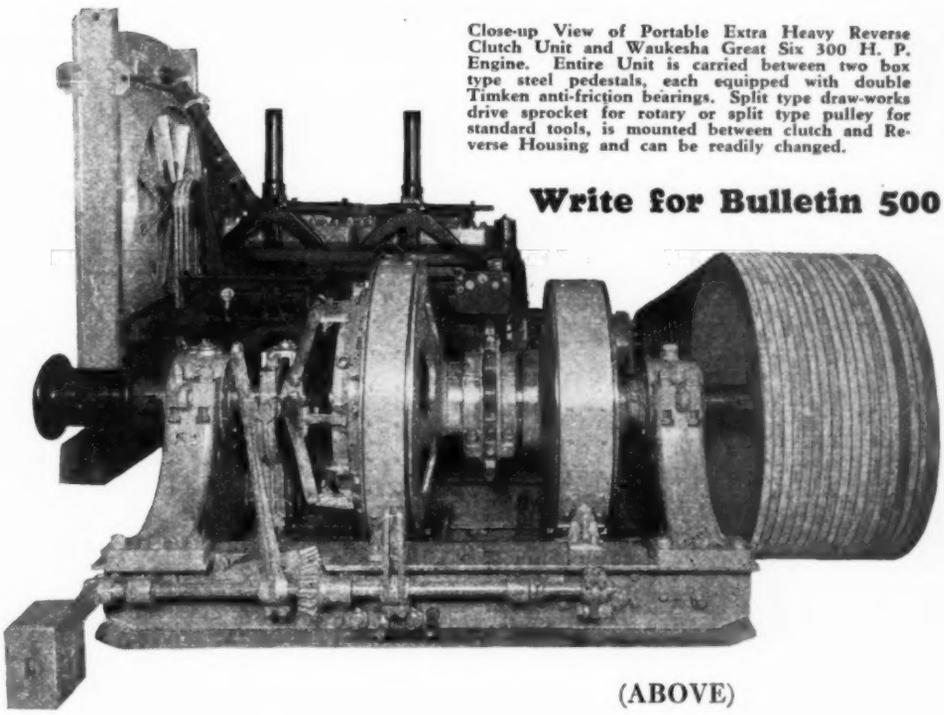
(BELOW)

Heavy Duty 36″ x 4½″ Three Speed Draw-Works Power and Pump Unit

Powered by two 125 H. P. Waukesha engines with the latest type heavy duty herringbone reduction gears. The units are arranged so that the power of either or both engines singularly or simultaneously can be used to drive the slush pump or diverted to the draw-works if desired by the operator.

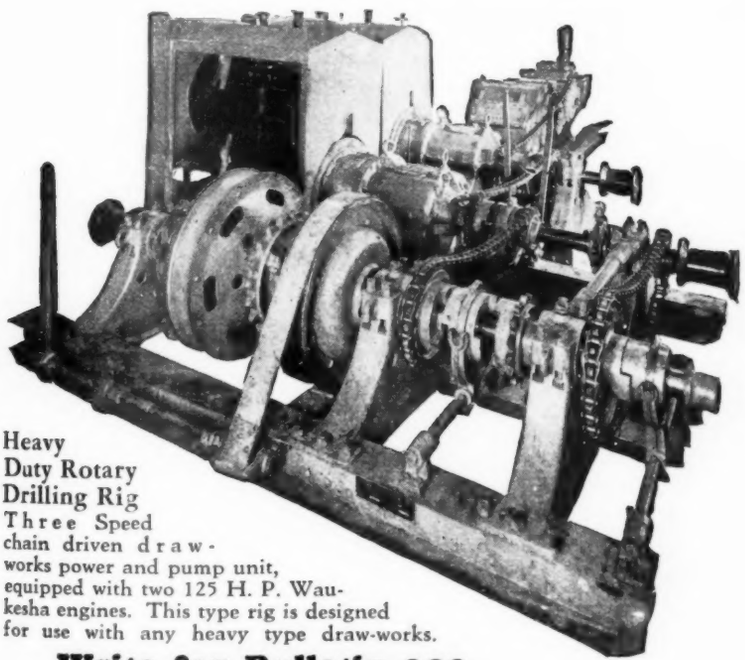
The entire unit is mounted with anti-friction bearings which operate in a bath of oil. The rig is operated from driller's position by a single lever control. It may be run on gasoline or natural gas.



Close-up View of Portable Extra Heavy Reverse Clutch Unit and Waukesha Great Six 300 H. P. Engine. Entire Unit is carried between two box type steel pedestals, each equipped with double Timken anti-friction bearings. Split type draw-works drive sprocket for rotary or split type pulley for standard tools, is mounted between clutch and Reverse Housing and can be readily changed.

Write for Bulletin 500

(ABOVE)



Heavy Duty Rotary Drilling Rig Three Speed chain driven draw-works power and pump unit, equipped with two 125 H. P. Waukesha engines. This type rig is designed for use with any heavy type draw-works.

Write for Bulletin 300

Extra Heavy 42″ x 6″ Reverse Clutch Unit

This unit is powered by a Waukesha 300 H. P. Great Six Engine. This power is transmitted to the Reverse Clutch Unit through 18 Texrope belts.

The Reverse Clutch is of the oil bath type with steel cut gears and hardened pinions. The housing construction is of the floating type. Method of applying reverse friction band allows over 90% of friction surface in contact with drum. The entire construction is of steel, thus assuring strength and long life.

The forward clutch is single plate construction with friction segments on both sides of plate and is so constructed that it is not necessary to remove shaft from bearings or disturb any of assembly except tie bolts in clutch housing to renew friction discs when they have become worn. This is due to split construction of driving plates.

Portable Rigs are made in sizes ranging from 1200 feet to 6000 feet drilling depths.

PORTABLE RIG CO. INC.

HOUSTON, TEXAS

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method from a benzol value of fifty-six to a value of thirty-seven.

Good results were obtained in restoring the anti-knock properties of the Mid-Continent cracked gasoline by treatment with any of the following treating agents: Fuller's earth, 75% sulfuric acid, 95% sulfuric acid, 16° Be. caustic soda, 40° Be. caustic soda; and borax in the rerun stills. With the same treating agents applied to a Pennsylvania cracked gasoline, all but the Fuller's earth and the 40° Be. caustic soda gave partial or full regeneration.

The detailed results on regeneration are shown in the following table:

TABLE 12
RESTORATION OF KNOCK RATING
PENNSYLVANIA CRACKED GASOLINE

	Original Gasoline	After Oxidation	3 lbs. per bbl. Fullers earth	Rerun over Borax	3 lbs. 95% H_2SO_4	3 lbs. 75% H_2SO_4	3% 16°Be. NaOH	3% 40°Be. NaOH
I. B. P. °F	94	114	106	115	119	120	114	112
E. P. °F	427	434	434	439	436	438	434	437
Color Saybolt	24	—16	—11	+16	30	28	—16	—11
Mgs. Gum Copper Dish	18.7	220	257	30.9	5.1	10.5	178	144
Mgs. Gum Glass Dish	2.3	55	35	2.8	2.5	2.8	38	22
Hydrocarbons								
Per Cent—								
Unsaturates	24.0	23.0	.....	.....	.....	.....	.....	.....
Aromatics	22.9	22.5	.....	.....	.....	.....	.....	.....
Naphthenes	9.3	10.1	.....	.....	.....	.....	.....	.....
Paraffins	43.8	44.4	.....	.....	.....	.....	.....	.....
Delco Motor Test								
Benzol Equivalent Per Cent	40	29	27	40	40	37	35	29
MID-CONTINENT GASOLINE								
I. B. P. °F	103	114	118	114	119	120	112	114
E. P. °F	320	335	314	310	315	307	304	302
Color Saybolt	+30	+7	+10	+16	+18	+16	+16	+15
Mgs. Gum Copper Dish	68	475	580	83	55	73	347	219
Mgs. Gum Glass Dish	1	136	150	2	1.0	1.5	78	47
Hydrocarbons								
Per Cent—								
Unsaturates	36.2	41.1						
Aromatics	12.0	7.8						
Naphthenes	11.9	11.7						
Paraffins	39.9	39.4						
Delco Motor Test								
Benzol Equivalent Per Cent	56	37	48	50	51	51	50	52

Another set of experiments for restoration was made with a Mid-Continent cracked gasoline using reagents having reducing properties. The gasoline was exposed to sunlight in an atmosphere of oxygen to depreciate its knock rating. Sodium hydrogen sulfite, stannous chloride, and acetic acid and zinc restored the depreciated gasoline from a knock rating of sixteen per cent practically to its original benzol equivalent of thirty-two per cent.

The treatments were as follows:

1. Washing the depreciated gasoline with ten per cent by volume of a saturated solution of sodium hydrogen sulfite and then washing with water.

2. Washing with ten per cent by volume of a saturated solution of stannous chloride.

3. Refluxing for two hours with ten per cent by volume of glacial acetic acid and zinc dust, washing with water, neutralizing with caustic soda and then water washing.

The results are shown in the following tabulation:

TABLE 13

	Original Gasoline	Gasoline After Oxidation	Sodium Hydrogen Sulfite	Stannous Chloride	Acetic Acid and Zinc
Color	20	Yellow	Light Orange	Yellow	Yellow
Gum—Mg./100 cc., copper dish method	25	330	330	....	326
% Benzole Equivalent	32	16	30	28	30

Other reducing agents would probably show similar results in regeneration of the gasoline. These data lend added support to the theory that the chemical inhibitors act as anti-oxidants.

Conclusions

1. Although most cracked gasolines are satisfactorily stable during storage with respect to color, gum and knock rating, there are some that deteriorate.

2. There is no regularity in the formation of gum and lowering of knock rating.

3. The accelerated oxidation test for gums is applicable as an accelerated test for depreciation of knock rating of a gasoline.

4. Chemical inhibitors have been found which prevent loss of knock rating during accelerated oxidation.

5. New chemical inhibitors have been found which prevent gum formation during the accelerated oxidation of gasoline. It is expected that they will be effective in stored gasoline.

6. New chemical stabilizers of color for stored gasoline have been found.

7. Processes for the restoration of cracked gasoline which had depreciated in knock rating have been developed.

Explosions in Air Compressor Stations

CONTRARY to general belief, compression of air to the high pressures commonly required in oil field operations actually constitutes a greater hazard than the compression of natural gas to similar pressures. Investigations of the causes of explosions in air compressor stations indicate that a main contributing factor is the vaporization of lubricating oil in the discharge manifold header and the discharge line between the compressor and the header.

Unless adequate provision is made for thorough and efficient removal of waste lubricating oil from air compressor discharge lines, lubricating oil will accumulate and become a serious explosion hazard. As it is not general practice in the oil fields to after-cool air when compressed, this accumulation of oil, under the conditions of high temperature that exist in the discharge line, will vaporize, and an explosive mixture may result. It has been observed that immediately after starting up a compressor and cutting it into the line operating at high pressure, an explosion from this cause is most likely to occur.

Effective safeguards to offset this danger are to use care in the design of headers, and the installation of traps or baffles of an approved type in the discharge line close to the compressor.

Automatic Fluid Lift *Practical in* Keeping Gas Well Sand Dry

EXPERIMENTS with an automatic fluid lift designed by A. L. Griffith, Cushing, Okla., district superintendent for the Cities Service Gas Co., show the device practical in keeping the sand in gas wells dry and in some instances reviving old gas wells about to be abandoned.

The device is run on the tubing and, by atomizing the water with a spiral in the head, the well is permitted to flow steadily. This feature demonstrated its worth during the winter's first cold snap, because, instead of the wells on gathering lines heading and dumping a big volume of water into the lines at one time, their flow was steady and the drips handled the water, the steady agitation thus eliminating freezing troubles.

The lift is built with 2½-inch tubing and is seven feet, six inches over all. Inside is a half-inch iron pipe to carry the water to the spiral in the top, where it is atomized and flowed out uniformly with the gas.

On the bottom section, which is about four and a half feet long, are several ⅝-inch perforations. This section is sealed off from the remainder by a disc through which the half-inch pipe is run. This prevents the water from getting into the top part after the well is unloaded and causes it to flow up to the spiral through the small pipe. The spiral is welded near the top of the device and to the half-inch pipe. Perforations in the top section of the lift permit the gas to flow into that part of the device, and, when the gas flows to the spiral, it swirls the water around it, causing atomization of the water.

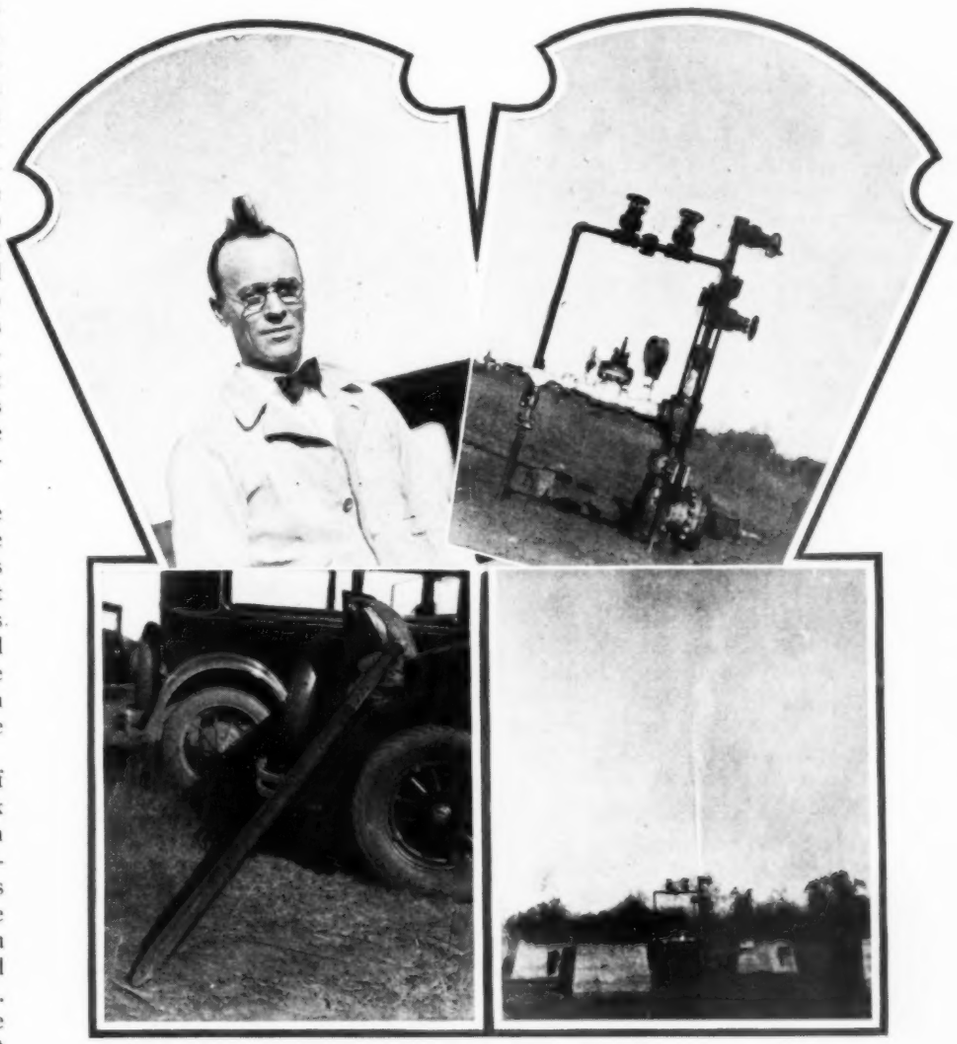
The fluid lift is closed on the bottom by pinching the end of the tubing into a spear head. This type is designed for wells that have not drilled through the gas sand and gives the lift a good seat on bottom. It can be made for an anchor for wells which have been drilled through the sand.

One of the best examples of reviving the open flow and rock pressure of a gas well is found in the Bristow field. A well had almost been drowned out and was about to be abandoned. When the well was tubed it had an open flow of 3,100,000 feet of gas and a rock pressure of 110 pounds. After being produced through the fluid lift for several months it showed on a recent test 5,440,000 feet of gas and that the rock pressure had increased to 310 pounds.

Representative records being kept on 15 wells in scattered fields in that section of Oklahoma show that where the lift has been installed the wells have all shown an increase in open flow and in all but one instance the rock pressure has increased.

While evidence is lacking as to what corrosion may be doing to the half-inch pipe inside the device it is planned to use a pipe made of metal highly resistant to corrosion in wells where severe conditions exist.

The operator who is faced with the problem of handling small gas wells might be interested in equipment of this character. Where gas wells having a daily average yield of a few million cubic feet are found to have water collecting on the sand, to use a string of tools for clean-cut purposes is a rather expensive proposition.



Above, left—A. L. Griffith, Cushing, Okla., district superintendent Cities Service Gas Co., who designed the automatic fluid lift. Right—Connections on gas well equipped with automatic fluid lift.
Lower, left—Griffith automatic fluid lift device for gas wells. Right—Gas well unloading water with automatic fluid lift.

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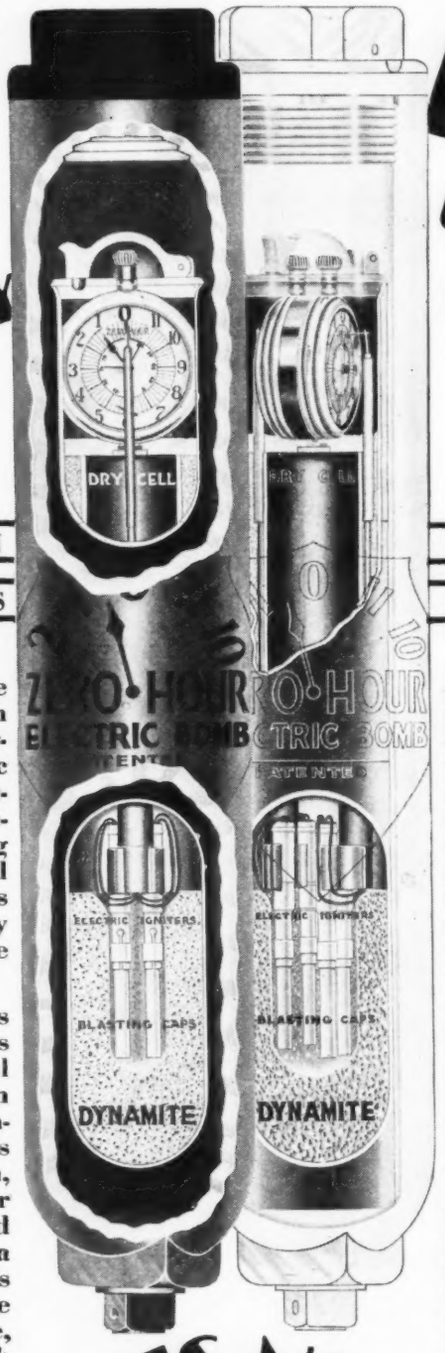

THE ONLY BOMB BETTER THAN ZERO HOUR BOMBS, AND THAT'S THIS NEW

Zero Hour Electric Bomb DUPLEX

Plug and Socket Connectors ... Improved Firing Pin

A ZERO HOUR BOMB IS TWO THE ZERO HOUR DUPLEX

Attention to detail, so that the acme of efficiency may be obtained with the plainest simplicity, is a characteristic of Duplex Zero Hour Electric Bomb design. The result is an electrically operated, time-controlled detonating device for oil well shooting that enjoys favor in Argentine as well as in Oklahoma, in Burma as well as in Texas, and can be operated by any person who understands the English language.

A principle of operation as simple as that of a pocket flashlight controls the firing of this bomb—electrical contact. The pressing of a button closes a circuit and lights the flashlight. In the bomb, the circuit is closed by the action of a watch, keeping regular time, until its hour hand touches the firing pin located at the "zero hour," indicated by a red "0" on the watch face. At this point the bomb explodes, the same as the flashlight lights. A novice, who need only know what a watch and battery are, and hardly that, by following the direction sheet which comes with every Zero Hour Bomb, may set and load a Zero Hour Bomb with perfect ease and safety—and with added assurance, in the new Duplex Zero Hour Bomb, of double dependability.

The same size container that formerly held the original Zero Hour Bomb, with one watch and one set of blasting caps, now holds the Duplex, with two watches and two sets of blasting caps. Duplication of the vital working parts of the bomb, namely the watch and its firing connection with the blasting caps, forms the Duplex principle. Thus, two complete timing and firing mechanisms, each independent of the other, are enclosed in the same metal, fluid-tight container that formerly held one only, reducing the chance of a failure with the new Duplex Bomb to a figure so small that it is almost beyond computation in ordinary mathematics. In setting, this means only the winding and setting of an additional watch, identical with the first one, followed by the attachment of an additional igniter and blasting caps. This attachment has been simplified by a plug and socket connection, making it like plugging in an electric light cord in the wall and insuring perfect electrical connections. A gold spring firing pin, with tempered flexibility, holds accurately to the "0" firing point, no matter how often the hour hand passes either forward or backward across it, in testing. A denotating device that operates on such a logical, time-tested principle as that found in a flashlight, and controlled by such a symbol of dependability as a pocket watch, provides the same logical assurance of dependable results, sponsoring marked efficiency and economy.

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When writing THE ZERO HOUR TORPEDO COMPANY *please mention The Petroleum Engineer*

An Unusual Hook-Up Used on
Oklahoma's Record-Breaking Well

A HOOK-UP unusual in Oklahoma was made by the Indian Territory Oil Illuminating Co. when its No. 1 Thomas Fuzzell, SW SE SE Section 13-11-3w, in the Oklahoma City Field was completed as the state's record-breaking producer. Although not as large by far as world's record-breaking producing wells, when it produced 42,982 barrels in 24 hours from a total depth of 6,542 feet it easily surpassed the record of 25,865 barrels made by the Sinclair Oil & Gas Co.'s No. 27 Hartley in the Garber field.

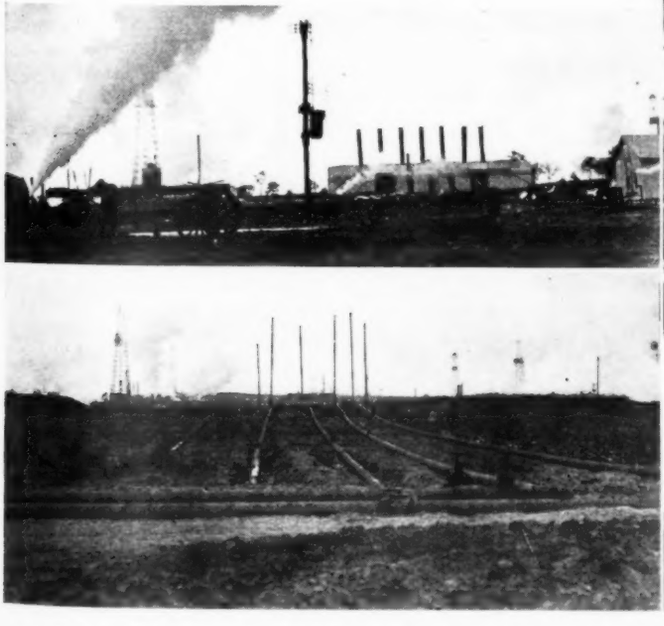
During its 24-hour run before being shut in under proration, the well made 39 gravity oil at 60 degrees and was not cutting when shut in. It was flowed to two big separators and one smaller one through three 6⅝-inch lines. Six control valves were put on the well, three above the derrick floor and three below. The three below are 5,000-pound test gates and those above the floor are 3,000-pound test valves. Five risers are employed to handle the 39,000,000 feet of gas from the well which a closed-in pressure of 1,100 pounds.

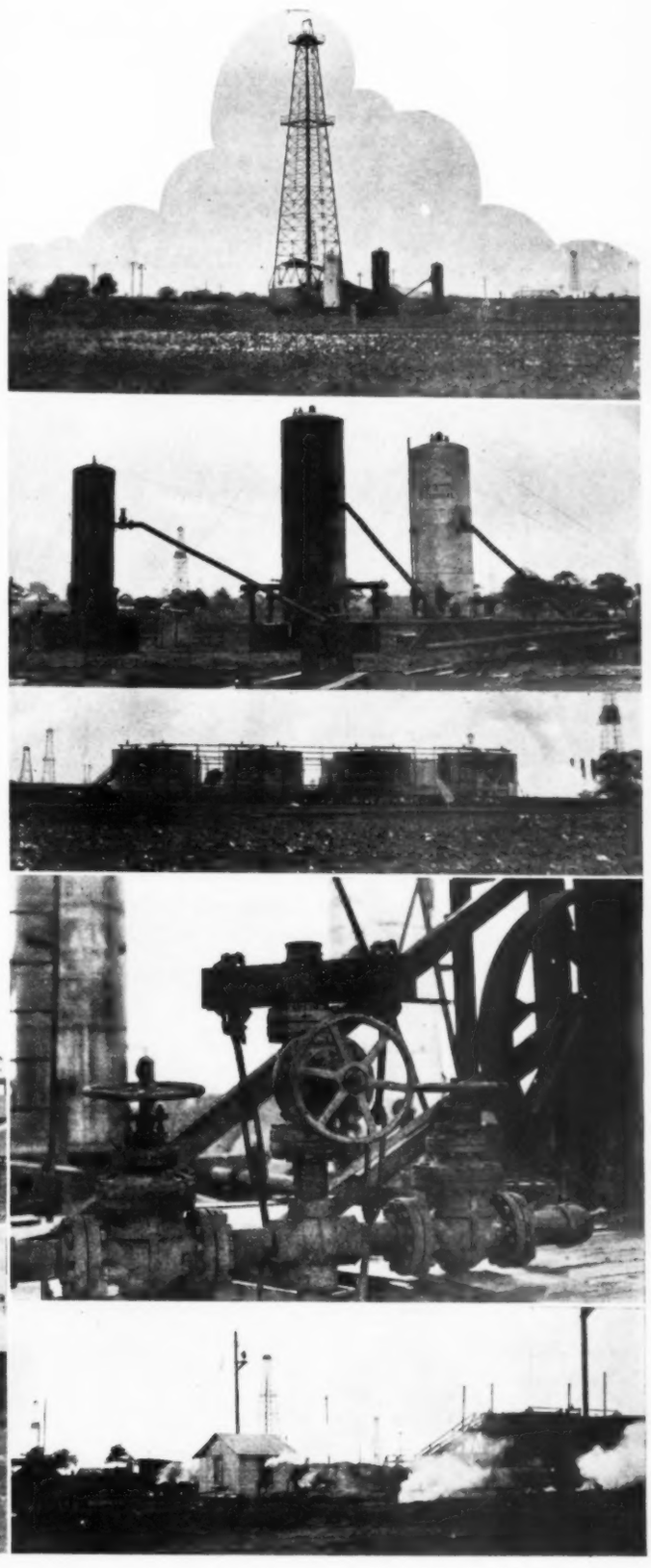
A watchman is kept constantly on the well to keep onlookers from tampering with the valves. The master gates are kept locked with a chain and padlock as a further protection.

Two batteries of 1,000-barrel tanks, eight in each battery, are required to handle the production for the three pipe line companies taking the oil. The oil is delivered to the transporters with two small centrifugal units and a like number of steam pumps. A boiler station housing seven 75 horse power boilers was built to supply steam for the oil pumps and for use in case of fire.

The well has two remote control manual stems coming from two master gates in the cellar. These are attached to the gates with a universal joint and the stems are made with joints of pipe welded together.

After flowing its first full 24 hours the well was shut in for 30 days. Around the middle of December the well will be put on production.





Right-hand column, top to bottom, the big well; the separators handling its output; the battery of tanks; a close-up of the derrick floor; and get view of the location. Left, above, the boilers at the well; below, the risers which handle the gas.

Gas vacuum line of Naylor Pipe at St. Louis, Oklahoma. 40'0" joints, 16" diameter.

Lowest Cost Per Foot In The Ground

NAYLOR PIPE costs less per foot in the ground than any other pipe carrying standard weight pressures. No other pipe can be laid as cheaply.

Naylor Pipe is the lightest of all pressure pipe. It weighs only half as much as standard weight wrought pipe.

This light weight is a money saving advantage. It means half the freight to pay; half the weight to haul; half as many men needed for handling in the field; speedier laying. These advantages lower your pipe line costs.

Besides light weight, Naylor Pipe is also made of Toncan Iron for greater resistance to rust and corrosion. Longer life of the pipe means fewer renewals..consequently, lower maintenance costs.

Lay your next pipe line at the lowest cost per foot in the ground. Naylor Pipe will help you to do it.

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Training *of* Refinery Technologists

By PROFESSOR RAYMOND L. ABEL

Dept. of Petroleum Refining, University of Pittsburgh

THE progress of the petroleum refining industry in the past decade has been marked as much by notable changes in methods of refining as by the amazing growth of the industry. With these changes has come a greater appreciation of technically trained men on the part of refinery executives. In most instances, however, the need of a special type of training has not been felt. Some large refining companies have established training schools for young technical graduates wherein they receive a type of instruction and practical training deemed essential to their orientation in the industry. Such a program is obviously beyond the province of any but the larger organizations.

A few educators as far back as 1919 were sanguine enough to believe that a particular type of university training should be offered young men who planned entering refinery work. Since then, several universities have offered one or several courses in refinery technology and, at least, one university has had a distinct department of Petroleum Refining which has granted both undergraduate and graduate degrees for the past six years. The success of graduates in refining technology has, to say the least, satisfied expectations and bids fair to create a definite demand for them from the industry.

In the creation of a curriculum for the training of refining technologists, the question arises as to the most suitable type of training to be embodied therein. Shall it be training in chemistry, business administration, engineering or what? The consensus of opinion is that the engineering type of training is best.

Refinery executives and educators agree that the completion of a sound course in engineering does not insure success in the operating branches of refining. But they do agree that such training is the most positive aid to the man who through natural ability and aptitude would be a successful operator. The increased frequency with which engineers are reaching the higher executive positions in manufacturing industries indicates that the disciplinary value of such training ranks high; it is, indeed, a very encouraging sign to those about to enter the profession.

Granting then that a course in refining technology should be fundamentally of an engineering nature, what should be the content of the curriculum?

The accompanying outline of courses shows substantially the curriculum employed by one university during the past eight years in the training of refinery technologists.

Students completing the course receive the degree of Bachelor of Science in Petroleum Engineering. Upon completion of, at least, three years of work in a refinery and presentation of a satisfactory thesis showing the application of engineering principles to the solution of some refinery problem, the graduate receives the degree of Petroleum Enginer.

A glance at the curriculum will show that the chief aim embodied in it, is the training of a professional man and not simply an operator of equipment. Although cognizance is taken of the fact that the graduate should be of immediate value to the extent of the salary paid him, this is subordinated to more basic training that is less easily acquired in the plant.

The course furnishes, primarily, training in the sciences and basic subjects of engineering. More chemistry is included than is found in the usual courses of mechanical engineering and more engineering subjects than are offered in courses of chemical engineering.

The point of view that courses in refining technology should not be elaborated to the exclusion of basic engineering courses, however, imposing they may appear on a schedule of studies, seem to have been justified by experience. Such courses should be placed in the latter part of the curriculum. The fundamental scientific and engineering principles to which the student was introduced in prior general courses, can be fixed in mind by application in the refining courses to specific problems of the industry.

Laboratory courses, obviously, cannot furnish adequate training in the technique of handling plant equipment. Such training is a problem for the refinery itself. In the course of study outlined above, valuable practical experience in refinery work is obtained by the co-operation of refineries with the university. During the several periods of co-operative work totaling about one year, the student to all intents and purpose, is an employee of the co-operating refinery. While the work and pay are important, the most direct benefit derived by the student comes from the opportunity to observe the problems of and conditions within the industry. While at work in the refinery, the student is visited, at frequent intervals, by a member of the faculty who discusses with him the work he is doing and its relation to the theoretical training he receives in the university.

Laboratory courses most properly acquaint the student with the standard methods of testing petroleum products and the experimental study of refinery processes as practiced in refinery laboratories.

It is felt that minor courses in Petroleum Geology and Production Engineering are valuable parts of the curriculum. They open to the refinery engineer important allied fields and give him a foundation upon which to make an independent study of them in later years.

Despite the remarkable technical advances of the refining industry in the past few years it can hardly be questioned that these are but a beginning. The utilization of petroleum as a source material for the manufacture of various organic derivatives, has already begun and holds the interesting possibility of creating a huge chemical industry. The methods of cracking, treating, etc., are undergoing constant change and improvement.

All these developments are sure to make the services of technical men more valuable to the industry and create a demand that will either be filled by far-sighted universities keeping pace with the advance or will necessitate more careful training and selection of technical men within the industry.

In any event, whatever trend the refining industry takes, the future of the technical man within its ranks seems assured.

OUTLINE OF COURSES FOR A DEPARTMENT OF PETROLEUM REFINING

Freshman Year

Course	Subject	1st Semester Hours Recitation	1st Semester Hours Laboratory	2nd Semester Hours Recitation	2nd Semester Hours Laboratory
English	English Composition	4	0	4	0
Mathematics	Algebra, Trigonometry, and Analytical Geometry	4	0	4	0
Chemistry	General Inorganic Chemistry	3	4	3	4
Civil Engineering	Mechanical Drawing	0	3	0	3
Economics	Principles of Economics			3	0
Psychology	Introduction to Psychology	3	0		
	Physical Education or Reserve Officers' Training Corps	0	3	0	3
		14	10	14	10

Sophomore Year

Mathematics	Differential and Integral Calculus	4	0	4	0
Physics	General Physics	3	6	3	6
Chemistry	Qualitative and Quantitative Analysis	2	6	2	6
Geology	General and Historical Geology	3	3	3	3
Physics	Applied Mechanics			4	0
Civil Engineering	Plane Surveying	1	3		
		13	18	16	15

Five Months of Co-operative Work in a Refinery

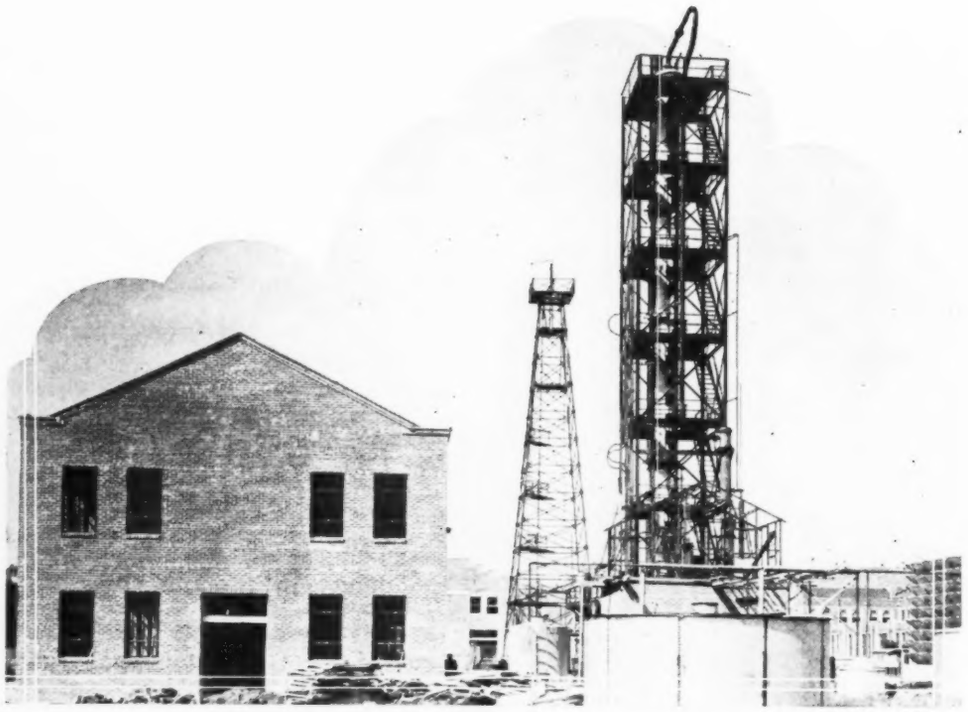
Junior Year

Civil Engineering	Mechanics of Materials	3	2		
Civil Engineering	Hydraulics			4	3
Mechanical Engineering	Heat Power Engineering	2	3	2	3
Chemistry	Physical Chemistry	2	3	2	3
Chemistry	Organic Chemistry	3	5	3	5
Refining	Refining Practice	2	3	2	3
		12	16	13	17

Five Months of Co-operative Work in a Refinery

Senior Year

Refining	Refinery Design and Construction			1	6
Chemistry	Colloid Chemistry			2	0
Business Administration	Business Principles	3	0		
Business Administration	Business Law			2	0
Mechanical Engineering	Steam Power Plant Engineering	2	3	2	3
Electrical Engineering	Applied Electricity	2	3	2	3
Oil and Gas Production	Oil Geology	4	0		
Oil and Gas Production	Technology of Production			2	0
Refining	Chemistry and Principles of Refining	2	6	2	3
Refining	Seminar	1	0	1	0
		14	12	14	15



The New Petroleum Engineering Laboratory of the University of Oklahoma

"Charley" Brant has used 'em all

Mr. C. P. Brant, ... Indianapolis, Ind., and an oil well he drilled with UNION Wire Rope in the Muskegon, Mich., field.

Mr. C. P. (Charley) Brant, who is still in the contracting business at 75 years of age, was one of the pioneer users of wire rope for oil well drilling. He has used all makes—but finds that UNION Wire Lines are the last word in *service*. His three strings of tools are equipped with UNION Wire Lines.

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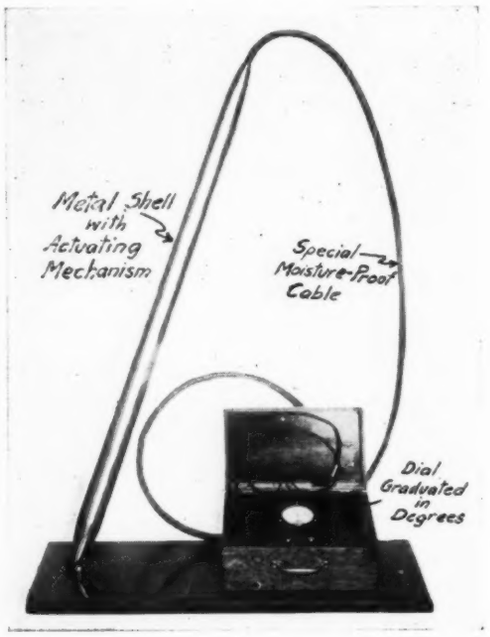
Device Measures Vertical Deviation of Holes With Speed and Accuracy

IT is gradually becoming general practice to test wells for vertical deviation while drilling. If the deviation is too great, the hole is plugged back and redrilled. When this procedure is followed and vertical deviations are kept within narrow limits, the necessity for measuring horizontal deviation assumes less importance.

With these facts in mind, the Driftmeter was designed and developed for oilfield use. It is an electrical device, amazingly simple in operation and construction, for measuring the vertical deviation of a hole. By its use a hole of any depth and size can be surveyed for vertical deviation with the utmost ease, speed and precision. An idea of the simplicity of the apparatus can be had by noting the essential parts of the device in Fig. 1.



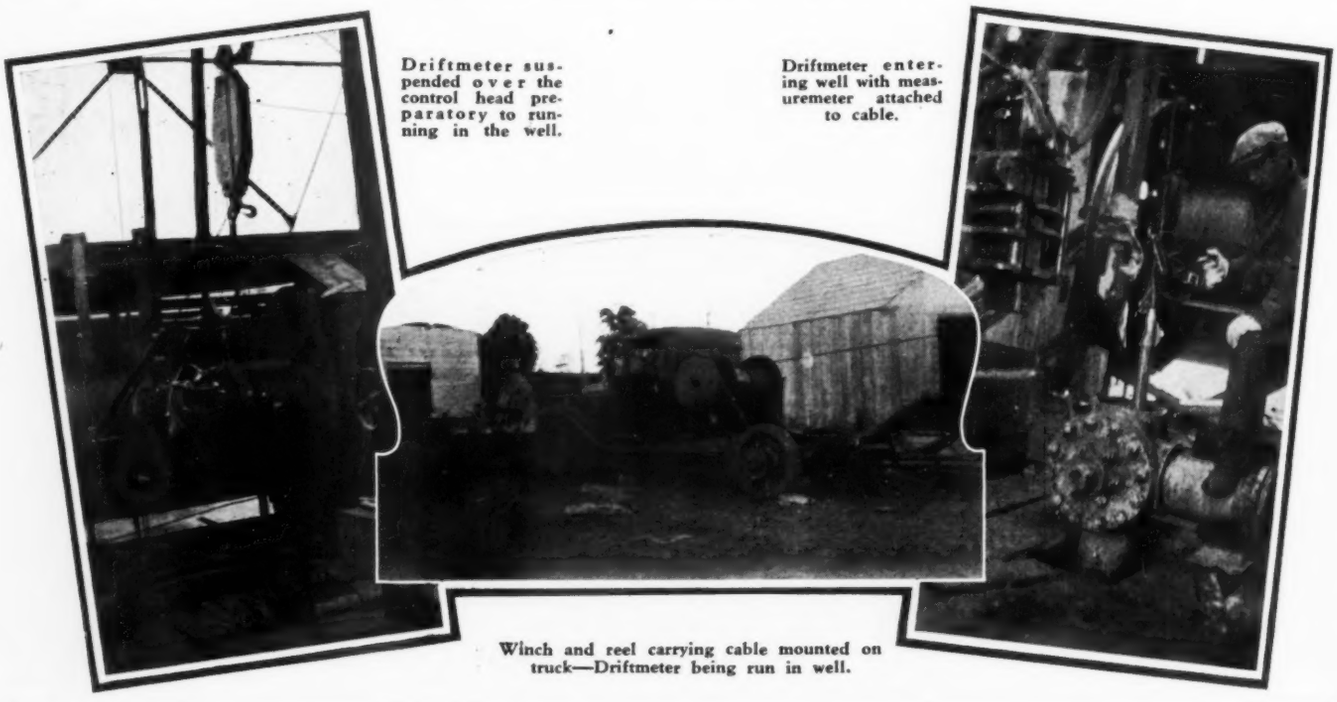
Showing the essential parts of the Driftmeter for measuring the vertical deviation of holes.

In operation, the metal case containing the actuating mechanism is run on a special cable which serves as an electrical conductor between the case and the dial. Switches are mounted at the dial to control the electrical circuit through the contact mechanism and may be actuated at the will of the operator. Readings can be taken either inside the drill pipe, casing or tubing, or in open hole. Readings showing the vertical angle of the hole are obtained direct by the operator on the derrick floor by the simple operation of a switch. Any desired number of readings can be taken in one run in the hole. Check readings can be taken if desired, one set while running in and one set while pulling out.

The whole apparatus is entirely portable and self contained and can be mounted on a truck with reel and winch as shown in Fig. 2. The metal case, which weighs about 40 pounds and is approximately four feet long, is made in three sizes, 4, 2⅞, and 1.9 inches diameter, respectively. Suitable guides for keeping the case central in the hole and for any size hole can be conveniently attached to the case.

Data taken in actual field tests are shown in Tables 1 and 2. Note the close, consistent agreement between the acid-bottle and Driftmeter readings. These were both producing wells and the average total time for the survey in each case was less than three minutes per reading. In another well in the St. Louis Pool, Seminole District, Oklahoma, 17 readings were made in 37 minutes (exclusive of pulling-out time) in 8-inch casing full of heavy mud fluid. On a drilling well in Lincoln County, Oklahoma, 16 readings inside the drill pipe in mud fluid, were taken in 50 minutes, including the time pulling out. Measurements were made on the latter well by "flagging" the cable which caused some delay. Dial readings were always checked back to zero as the instrument came out of the hole.

The time element is a very important factor in surveying deep drilling wells. In the complete survey of a hole, it should be possible to make an average speed of 1½ to 2



Driftmeter suspended over the control head preparatory to running in the well.

Driftmeter entering well with measuremeter attached to cable.

Winch and reel carrying cable mounted on truck—Driftmeter being run in well.

minutes per reading. In addition to the advantages of ease and speed of operation and the direct angle readings obtainable, the device is non-magnetic. Rigid tests with magnets in direct contact with the outer shell showed no perceptible change in dial reading.

Howard S. Splane and W. W. Hester are developing the Driftmeter under the name of Driftmeter Inc., at 616 Exchange Bank Building, Tulsa.

TABLE 1

Depth in Feet	Driftmeter Reading-Deg.	Acid Bottle Reading-Deg.
174	2	....
217	3	....
278	3	4½
502	7	....
772	12½	13
1019	21	22½
1272	28	25½
1396	31½	27½
1518	37	35
1589	39	....
1638	41	....
1692	42+	....
2510	42+	42
2553	42	....
2765	38	35½
3018	34	32½
3264	31½	30

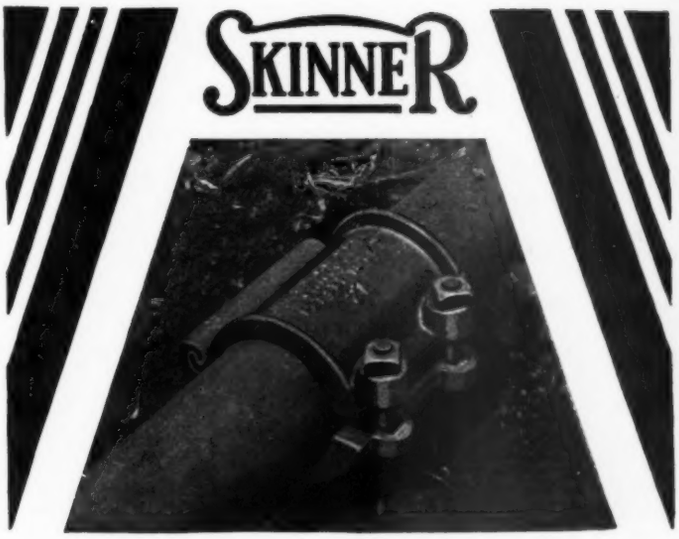
Wells in Bowlegs Pool, Seminole District, Oklahoma.
6⅝ casing, 1,000 feet oil in hole.
17 readings taken in 30 minutes.
Time to pull out, 15 minutes.
Total time, 45 minutes.

TABLE 2

Depth in Ft.	Driftmeter Reading, Deg.	Acid Bottle Reading, Deg.	Acid Bottle Reading, Corrected, Deg.
252	0	0	0
499	2	0	0
748	1	4	4
1005	4	6	7½
1257	10	10	12½
1360	10	....	....
1512	17½	16	19½
1758	17	16	19½
2002	24	24	28
2094	28	....	....
2268	28	28	32½
2502	34½	34	38½
2745	38	35	39½
3009	40½	37	41½
3255	39	36	40½

Well in Mission Pool, Seminole District, Oklahoma.
6⅝ casing, hole full of oil.
15 readings taken in 25 minutes.
Time to pull out, 15 minutes.
Total time, 40 minutes.

BULLETIN No. GEA-1162 and GEA-569C have been mailed out by General Electric Company. The former concerns a pressure governor which is recommended for use with automatic starters for alternating-current motor-driven pumps or compressors to maintain a constant pressure between set limits on liquid or gas systems.



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Dewaxing of Lubricating Oils

E. R. LEDERER* *and* R. BEATTIE*

THE phenomenal growth of aviation, making it possible for a plane to leave a temperate zone and the same day land in a frigid zone, together with the constantly increasing use of automobiles in winter, has led to improved dewaxing methods.

The usual practice in the manufacture of paraffin base motor oils had been to blend a cold settled bright stock with a pour from 40 deg. to 60 deg. F., with a neutral produced from a wax distillate partially dewaxed by pressing. The pour point of the neutral ranged from 20 deg. F. for a single pressed to as low as 0 deg. F. for a double pressed product. The resultant pour point of the blend usually ran from 20 deg. to 50 deg. F. The newer methods give bright stocks with pours between 20 deg. and —10 deg. F. with, therefore, correspondingly lower pours on the blend.

The increasing use of air travel has caused many changes to be made in the processes of manufacturing lubricating oils. The plane makes harsh demands upon the lub oils, for in a very limited space of time the ordinary ship in passenger service may encounter rapidly-changing climatic conditions.

Centrifugal Wax Separation

The general procedure followed in the manufacture of Sharples bright stocks is as follows: The stock to be dewaxed is blended with naphtha in about 30-70 mix in the order named. Characteristics of the naphtha vary according to the specific requirements of the stock being processed. Narrowness of distillation range seems to be the characteristic that affects economical operation the most. The end point should be below 400 deg. F. to insure high gravity of the solution, and the initial fairly high to avoid evaporation losses as much as possible.

The theory upon which this system of separation is based demands a differential in gravity between the precipitated wax and the solution from which the wax has been precipitated. The determination of this differential and the magnitude of it depends on the gravity of the naphtha used and the characteristics of the stock being dewaxed. Just as in cold settling, the greater tendency of the wax to settle, the more wax removed under given conditions; so also in the Sharples centrifuge, the greater the gravity differential, the more separation occurs under given conditions.

After blending, the solution is chilled comparatively slowly. From the blending temperature of from 100 deg. F. to 110 deg. F. down to +20 deg. F., the hourly decrement varies from 3 deg. to 5 deg. F.; from 20 deg. F. down to the final temperature (from —20 deg. F. to —50 deg. F.) the chilling rate may be increased considerably. After reaching the final temperature, the solution is fed continuously to the centrifuges.

The essential feature of centrifugal separation of the wax from the lubricating oil is the continuous discharge of wax from the machines, and for this purpose a special rotor has been constructed. Hot water at a temperature of 140-145 deg. F. is fed by jets into the head of the machine. The water being heavier than the wax or oil maintains itself as a flexible carrier in the form of a cylindrical layer on the periphery of the rotor of the machine. The stiff wax is deposited upon the surface of the water, which conveys the wax from the machine, thus insuring a complete and continuous separation of the wax from the oil. Anything that will prevent or retard this continuous discharge of wax, such as insufficient water, clay, or other foreign particles, will have a very marked effect on the resultant pour test of the wax-free lubricating oil

In order to produce sub-zero pour tests by centrifuging, conditions in the plant must be ideal. Extreme care must be taken in reducing to avoid cracking. Tar and asphaltic bodies must be removed, in which are included the inhibitive or protective colloids which tend to keep the wax in solution.

Each centrifuge in the battery must be watched with extreme care, as the effect of one stream running high cold test oil makes a very marked effect in the aggregate. Special attention must be given the nature and quantity of the solvent used. If contact or percolation filtration is employed before dewaxing, the complete removal of "fines" is compulsory, or the resulting deposit in the centrifuge bowls makes low pour test impossible. It has been our experience after considerable work that the ultimate pour test obtainable by centrifuging a stock of 90 viscosity at 210 deg. F. is —10 deg. F. This is accomplished by using a special naphtha as a solvent and chilling the solution to —50 deg. F. This latter temperature is considered for the present by the authors as the lowest possible obtainable for economic operation.

A lower pour test, however, was obtained by altering the construction of the machine, so as to apply enough refrigeration, as near the bowl as possible, to offset the heating effect due to slippage and turbulence of solution in the bowl itself. Whether or not this problem can be worked out on a practical scale remains to be seen.

Weir Process

As it was the object of our research to determine the most economical way of producing sub-zero pour oils, we did not

*Texas Pacific Coal and Oil Co., Fort Worth, Texas.
Paper Delivered at Tenth Annual Meeting, American Petroleum Institute, Chicago, Ill., December 5, 1929.

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stop at the perception that the desired result could be obtained by centrifuging alone. The next step was to investigate the Weir process, which lately has undergone considerable testing by many companies. The principle employed in wax separation by this process is very simple in the words of Janus W. Weir in *National Petroleum News*, March 31, 1926:

"There is nothing mysterious about the process which consists of changing the filter cake from an impervious mass to a porous substance in the filter process by the use of a filter aid wherein a finely divided solid porous substance, such as diatomaceous earth, is mixed with a wax containing solution and extracted with the wax adhering thereto in the filter press. This simple statement should make it obvious that a differential in gravity in the process is immaterial, and that it is practical also for extracting wax of any nature from any stock."

The nature of this process makes it particularly adaptable to the stocks manufactured by the authors. Considerable research and development has been carried on in the laboratory, and some very good results were obtained. Before any semblance of commercially economic results were obtained, however, several mechanical problems had to be ironed out.

To begin with, we were aware that to produce the sub-zero pour tests we wanted, it would be necessary to chill the solution to at least —40 deg. F. A 3-ton Baker ice machine was used to supply refrigeration. In order to maintain capacity at these low temperatures (ammonia liquor —50 deg. F.), it was found necessary to install a small air compressor which was converted to act as an ammonia gas booster.

The chilling tank was made of ¼-in. plate with a dished bottom and no top. Insulation was attained by making a sheetmetal jacket 1 ft. in diameter larger than the tank, affording a 6-in. annular space, which was filled with ground cork. Suitable drains and outlets were provided by welding nipples in the bottom and sides.

Provision for mixing the cell was made by installing a jet mixing box and hopper. Dry filter-cel was emptied into the hopper; and the jet action supplied by a small pump mixed the solution and cell, sending it back to the tank. A stirring device was installed in the tank to keep the cell in suspension. The pump used was of the typical rotary type, gear-driven by a small motor.

Considerable thought was given the type of press to be used. After much consideration, one was selected which embodied all of the most desirable operating features. For example, in operation, the opening of the press was not necessary for the dumping of the cake, this being accomplished by a continuous closed discharge arrangement. Again, by the construction of the press, it was assured that an even cake would be built upon the leaves. A particularly desirable feature was the ease with which the whole system could be made vapor tight, thus reducing solvent loss by evaporation. Steaming of the cake for the removal of solvent is possible and, consequently, will reduce the solvent loss in the cake.

In the laboratory stage of this work, very encouraging results were obtained, pour points secured from —18 deg. F. to —28 deg. F. on stocks ranging from 50 viscosity at 210 deg. F. to 200 viscosity at 100 deg. F. Such work was accomplished by using gallon samples and vacuum filtering through a wax leaf with a small laboratory vacuum pump. When large-scale experimental work was started, weaknesses in the system showed up at once. In spite of ample insulation, the solution warmed up 20 deg. F. between the tank and the filter press. The filter-cel settled out in the lines and pumps, and refused to move. Moisture from the

atmosphere settled in the solution, froze in combination with the cell, and very effectively plugged the lines. The agitator was running too fast, throwing the cell to the outside of the chilling tank, giving a small amount of cell at the start of the run and a large excess at the last of the run.

The first corrective step was taken to install the press in a specially constructed cold room 6 ft. x 6 ft. x 8 ft. and refrigerated by another 3-ton Baker unit. With this arrangement, the press and cold room could be chilled down to —30 deg. F. before the run was started. At the conclusion of the first run with this new installation, an initial temperature of —25 deg. F. was noted. Investigation proved that, in circulating the solution through the press, the heat equivalent of the work done on the solution by the pump was the cause of most of the temperature rise.

Inspection of the connecting lines between the tank, pump and press disclosed many fittings which would produce additional turbulence, tending to put the wax back into solution.

In addition to these difficulties, the cell by nature is extremely abrasive. It was found by trial that the pump, although a slow-speed rotary type, wore out very quickly in pumping service. Another gear type pump was installed with not much better success, the amount of abrasion being almost prohibitive from an economic standpoint.

Another series of changes was made. The agitator in the tank was redesigned to give a minimum turbulence to keep the cell in suspension and reduce the centrifugal effect. The location of the press was altered so as to bring the press inlet connection not more than 3 ft. from the tank outlet. In place of pumping the solution bearing filter-cel, a top was installed on the chilling tank and natural gas was used to blow the solution to the press. The method of mixing the cell was changed so that no heating due to jet action was experienced.

At the conclusion of these and other minor changes in the whole installation, several successful runs were made. Noted below is a typical report on one of these runs.

Low Temperature Dewaxing (Runs No. 35 and 36)

It had become evident in the previous runs with the special filter press that the cold oil was warmed up too much before it could reach the press on account of the long line connecting the press with the chilling tank. In order to get around this trouble, a small four-leaf filter was installed directly underneath the chilling tank. The filter drum has a jacket for cooling from the outside with ammonia. The leaves can be cleaned by unbolting the front plate of the drum.

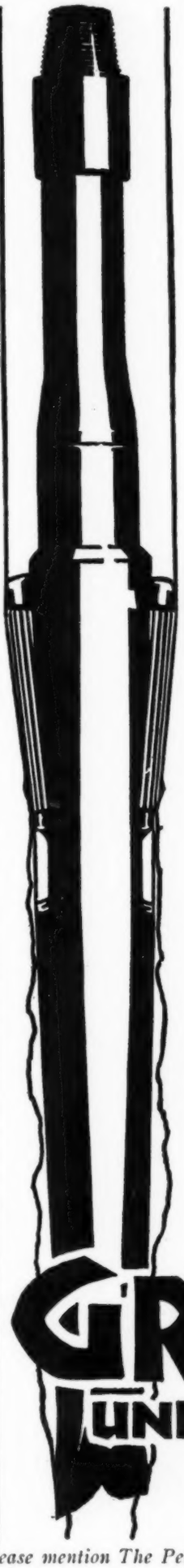
One hundred sixty gallons of wax-free oil from the Sharples plant were chilled to —42 deg. F. Two runs were made: No. 35 with ½ lb. of hy-flo super-cel per gallon of stock, and No. 36 with 1 lb.

The addition of 1 lb. of filter aid per gallon of stock to a 25/75 solution of oil in naphtha, as the one used in the present runs, raised the temperature from —42 deg. F. to about —36 deg. F. The temperature of the oil in the chilling drum was —42 deg. F. at the start. During run No. 35 the temperature in the chilling drum was —39 deg. F., ½ lb. of hyflo super-cel having been used, and during run No. 36 the tank was at —36 deg. F.

TABLE 1

Test on Wax-Free Oil
Pour Point +20 Deg. F.

Run No.	No. 35	No. 36
Temperature of solution in drum	—39 deg. F.	—36 deg. F.
Hy-flo super-cel per gal. of stock	½ lb.	1 lb.
Filter rate, gal. per sq. ft. per hr.	15	17.5
Cake thickness	½ in.	1 in.



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Samples of Run No. 35

Sample No.	1	2	3	4
Outlet temperature, deg. F.	—25	—25	—25	—28
Filter pressure, lb.	10	18	32	41
Pour point, deg. F.	—10	—10	—12	—12
A. P. I. gravity	24.6	24.6	24.8	24.2
Flash, deg. F.	435	435	440	445
Fire, deg. F.	495	505	495	510
Viscosity at 210 deg. F.	82	80	81	87

Samples of Rune No. 36

Sample No.	1	2	3	4
Outlet temperature, deg. F.	—24	—24	—24	—24
Filter pressure, lb.	12	21	40	49
Pour point, deg. F.	— 6	— 6	— 4	— 6
A. P. I. gravity	24.5	24.5	24.2	24.8
Flash, deg. F.	440	440	435	435
Fire, deg. F.	505	505	500	500
Viscosity at 210 deg. F.	84	84	84	83

Discussion

In our estimation, considering the short connection between chilling drum and filter, and in spite of the high outlet temperature, the temperature in the press was not more than 2 to 4 deg. F. higher than the temperature in the chilling drum. Based on this assumption, we arrive at filtering temperatures of about —36 deg. F. and —33 deg. F. for runs No. 35 and No. 36, respectively. The average pour points are —10 deg. F. for No. 35 and —6 deg. F. for No. 36. The difference between filtering temperature and pour point comes to about 28 deg. F., or even less. This result is as good as results obtained by vacuum filtration.

For comparison of vacuum and pressure filtration run No. 33 was made as a repetition and check of preliminary laboratory work using vacuum filtrations:

Eight gallons of a mixture of 40 per cent of Sharplessed stock, 70/75 viscosity at 210 deg. F., with a cold test of 5 deg. F. and 60 per cent of naphtha were chilled to —46 deg. F. A single filter leaf was immersed and oil was filtered out by means of vacuum.

TABLE 2

Tests on Reduced Filtrate Were as Follows:

Sample	1	2
A. P. I. gravity	24.4	24.6
Flash, deg. F.	440	445
Fire, deg. F.	505	520
Viscosity at 210 deg. F.	84½	86
Pour, deg. F.	—18	—16

Conclusions

The present results check previous results well, inasmuch as an average difference of 30 deg. F. between filter temperature and pour point is found consistently. Smaller differences have occurred, but they are exceptions.

While the experiments were going on, it was suspected for a while that some of the smallest wax particles suspended in the oil ran through the filter cake and filter, causing a larger differential than necessary between filtering temperature and pour point, particularly under the somewhat uneven action of the pump. For this reason, finer grades of filter aid were tried. As can be seen from the following table, the suspicion was unfounded and only the rate of filtration was affected.

TABLE 3

Grade of Filter Aid and Rate of Filtration

Run No.	23	24	27	28	25	26
	hyflo-super-cel		super-cel		filter-cel	
Lb. per gallon of stock	¼	½	⅓	⅔	⅓	⅔
Rate of filtration (gal. per sq. ft. per hour)	9.3	14	7.0	7.8	6.7	7.5
Average temperature difference between filter and pour point, deg. F.	30	30	30	30	30	30

Weir Process vs. Centrifuging

While the rate of filtration is an important economical factor ,it is within certain limits second to another variable introduced by the quantity of naphtha used for dilution. More naphtha means more power used per barrel of finished stock for chilling as well as distilling, to say nothing of increased losses of solvent. It is this factor that the advocates of the Weir process claim makes the filtering more economical than the centrifuging.

Comparing the Weir filtration method with centrifuging or cold settling, they claim that naphtha required for dilution in the Weir process amounts to 45 per cent; for centrifuging 65 per cent; and for cold settling 75 per cent.

In our filtration experiments on semi-plant scale, we found it necessary to use about the same amount of dilution naphtha that our commercial Sharples plant is using. When it was tried to cut down the naphtha, an abrupt drop in the rate of filtration was noted. This was the case with treated undewaxed long residuum. Partially dewaxed oils from the Sharples plant naturally could be filtered successfully with much less naphtha. Below are some figures.

TABLE 4

Naphtha Content and Rate of Filtration

Run No.	32	30	39	40	34
Temperature in chilling drum, deg. F.	—40	—40	—40	—40	+30
Lbs. of hy-flosuper-cel	½	½	1	1	1
Grade of oil	From Sharples plant		Treated long residuum		
Per cent naphtha	75	66	75	66	50
Rate of filtration (gal. per sq. ft. per hour)	15	13	15	0.3	—

It will be noted that in order to filter successfully this long residuum at — 40 deg., F., it must be diluted with not less than 75 per cent naphtha. The Sharpless plant has been running at — 25 deg. F. on the same residuum, the same naphtha and the same and lesser degree of dilution.

As far as quantity of dilution naphtha is concerned, it seems to us the two processes rate about equal. Naphtha losses will occur in either process, no matter what type of filter or centrifuge is being used. True, in the Weir process, the only loss of account occurs when the filter cake is being blown, and that can be reduced by employing steam or gas. The latter can be recirculated through an absorption system. But even such a process costs money, especially since the wet gas is likely to be rather lean as the blowing is done at very low temperatures; or in the case of steam, time and energy is lost by heating and rechilling the filter.

One of the big troubles in centrifuging is that a high gravity naphtha must be used for good operation, to have a gravity differential as large as possible between the solution and the precipitated wax. This creates high naphtha losses. The Weir process does not depend on any gravity differential. Any naphtha within reasonable distillation range can be used. This not only reduces evaporation losses, but also does not tie up a large quantity of as high grade a naphtha, for which there is an ever increasing demand on the market.

As previously mentioned, a temperature differential of 30 deg. F. between filtering temperature and pour point was found consistently for treated long residues. In centrifug-

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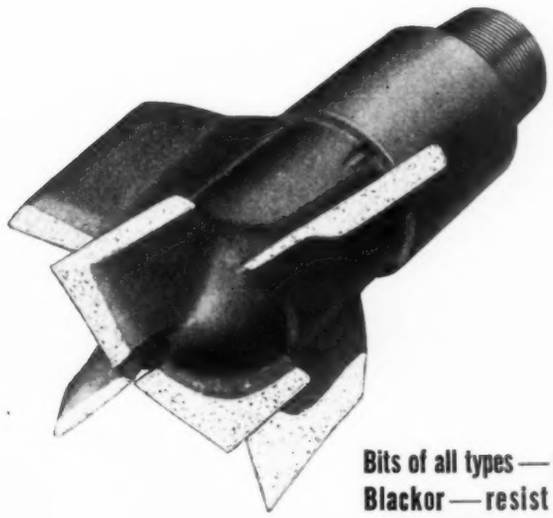

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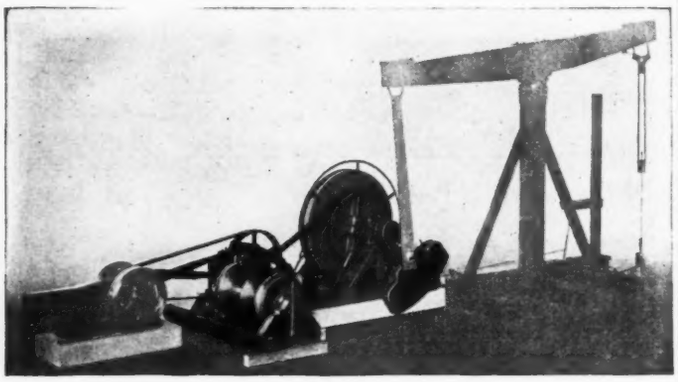

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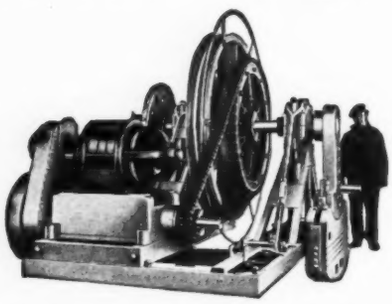

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ing, the differential between feed temperature and pour point depends on various factors, but under favorable circumstances a differential of 30 deg. F., or even better, can be obtained.

The biggest advantage of the Weir process probably lies in its mechanical simplicity as compared with a centrifuge installation. There are no high speed moving parts which, if not carefully attended, mean danger to life and property. There are few parts that need to be replaced regularly such as filter cloths, and these parts are cheap. Initial installation cost as well as wear of the Weir unit are relatively small.

From this short comparison of the two processes, it seems that the Weir process is the better, except for one phase: the petroleum recovery. The filter cake, after being blown, must be extracted, and the extract must be reduced in order to obtain the petrolatum; while petrolatum, as it is delivered by the centrifuges, needs only a reducing operation to recover the naphtha.

Looking at the two processes from various angles, one comes to the conclusion that it seems difficult to determine their superiority in regard to application on residual oils. This, of course, does not necessarily hold true where existing plant equipment or processes must be taken into consideration. While for one plant with its particular equipment and products the one process may prove advisable, for the next plant the other process may be superior. Some plants ,as a matter of fact, have installed both processes to suit their needs for handling various stocks.

Solvents Other Than Naphtha

All of our work previously outlined has been carried on using the standard solvent naphtha as employed in Sharples dewaxing. The employment of special solvents, such as alcohols, ketones, benzol, and chlorinated petroleum ethers have not as yet advanced to such a stage of development as to be in general use. With large scale employment of special solvents, the price should soon be within a range to permit economical operation. Much work along these lines is being done by several companies, mostly on an experimental scale. The only commercial installations, within the writer's knowledge, employing other than naphtha as a solvent are in Illinois.

General Economical Conditions

Naturally, the economic aspect of producing low pour test lubricant is of vital interest. Just where the happy medium is, between pour test on sub-zero cold test oils and manufacturing cost, is the subject of much conjecture with the refiners and marketers. From the consumer's viewpoint, if the fluidity performance improves in proportion to the lowering of the pour point, he can afford to pay a considerable premium for a special oil; this is more the case in aviation, because of the comparatively high maintenance cost and upkeep of aero engines. Again, the lowest desirable pour point is more or less governed by the extreme atmospheric temperature in which the product is to be used. A fair average for the United States in extreme cold weather conditions has been given as —20 deg. F. An oil with a good fluidity at this temperature, provided it has the other necessary characteristics, should answer all theoretical requirements of an all-weather aero oil. With these qualifications obtained, the problem of aero motor lubrication is now nearing its solution.

The inherent flow characteristics of the hydrocarbons present in any given lubricating stock govern, in the final analysis ,the lowest temperature at which an oil will flow. Let us consider set of examples of lubricating stocks from which all wax has been extracted, ranging from the least viscous, say 50 Saybolt seconds at 210 deg. F., to the most viscous, having 200 Saybolt seconds at 210 deg. F. The pour

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points of these samples plotted against viscosity will describe a straight line. The pour points in these cases are determined not by the presence of congealing waxes, but are determined by the congealing at low temperatures of havy cuts of lubricating stocks. Viscosity, then, is the ultimate limitin gfactor in the determination of minimum pour point.

From the refiner's viewpoint, many and varied complex factors affect the answer to the problem of the optimum low cold test. There is the question of the use of an economical, efficient, and easily recoverable solvent. By far the cheapest solvent in actual cost per gallon is a narrow cut, straight run naphtha, with about 200 deg. F. initial boiling point and 400 deg. F. end point. Availability, ease of manufacture with standard equipment, and simplicity of recovery still point to the use of naphthas as solvents. The flexibility, as far as initial boiling point, end point, gravity, and distillation are concerned, puts naphtha at the head of the list. Variations in these factors play a large part in the results of the actual dewaxing operation. According to an article in the June 1929 issue of the *Refiner and Natural Gasoline Manufacturer,* in which two-stage dewaxing, using the same solvent, is suggested, the use of any solvent other than naphtha is obviously excluded. The final separation of solvent by distillation—comparatively easy using naphtha—becomes more difficult, and may entail high losses when constant boiling liquids are used. Chlorinated petroleum products leave an undesirable trace of chlorine in the reduced stock, even when used diluted with naphtha. Benzol plus acetone and butanol, apparently the only other solvents employed on a large scale today, seem to be working economically.

TABLE 5

Viscosity at 210 vs. Pour Points of Oils Made From Straight Paraffin Base Mid-Continent Stock and Dewaxed at 40 Deg. F. by the Weir Process

Viscosity at 210 deg. F.	Pour, deg. F.
48	— 18
60½	— 12
96	— 8
118	+ 2
139	+ 6
160	+ 8
175	+ 14
201	+ 16

The lowest economical temperature to which a solution can be chilled, in the opinion of the authors, supplemented by the statements of several refrigerating equipment manufacturers, is —— 50 deg. F. This temperature, unless future mechanical developments alter the statement, seems to limit definitely the pour test on any given stock. As noted in the fore-mentioned test run, a constant temperature differential between solution and pour test of 30 deg. F. was noted using naphtha as a solvent. This gives an economical cold test of — 20 deg. F.

These temperatures are only obtainable by the use of direct expansion, the use of brine being prohibited by the freezing point of the saturated solutions. Many valuable contributions to this problem of chilling have been made by refrigerating equipment manufacturers in the last two years. The increasing use of direct expansion equipment, such as continuous chillers, chilling towers, and ribbon chillers, indicates that the minimum temperature requirements below zerow will be met in the near future by direct ammonia chilling. Much development work has to be done yet in devising ways and means of better temperature control, especially with reference to chilling rate. Such refinements are bound to come in

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the near future through the combined efforts of the refiner and refrigerating engineer.

Demand plays a natural part in the economical production question. Until such times as the volume of consumption reaches a point where quantity production is in effect, the manufacture of these extremely low pour test oils can be done only either with a very narrow margin of profit or with no profit at all. In 1926, no man would have predicted the phenomenal growth and development in aviation. In the face of the last three years' development, however, the logical conclusion can be reached that in not more than three years from date this economic phase of manufacture will be altered considerably for the better. Educational advertising will play no small part in the expected increase in consumption. The uncanny power of this factor has been well demonstrated.

The major element in the cost of production of aero oils has been the power cost for refrigeration. Our figures show that this item stands at the head of the list. Consequently, any developments tending to decrease the differential between chilling temperature and finished pour test will reflect very favorably on manufacturing cost. The one logical angle to attack this problem seems to be through the solvent employed. As has been demonstrated to the industry, proper preparation of the stock, insuring a minimum of inhibitives present, the type of solvent used, plus the rate of chilling, determine this differential. In the opinion of the writers, the answer is 90 per cent of the problem lies in the first two factors.

Finally, complexity of process and high initial cost are two factors faced by every refiner dewaxing or considering such an installation; cost of installation of essential equipment is very high; operations are very minute, and demand costly supervision and operators. With new and more efficient methods of wax extraction, this condition will in all probability adjust itself.

In conclusion, a glance at the latest development in aero motor power will give rise to room for conjecture from the refiner's viewpoint. Packard has taken the initial step and gone into quantity production in aero Diesel engines. Working characteristics relative to working pressure, speed, and temperature are entirely different and much more severe than in a gasoline engine. Whether this new step will materially alter the existing lubricating oil specifications remains to be seen. However, we can rest assured that as the demands become more exacting in the future, they can be met as excellently as they have been in the past, secure in the knowledge that the oil business can supply any product the public is willing to pay for.

Six Companies Constructing Lines in Oklahoma

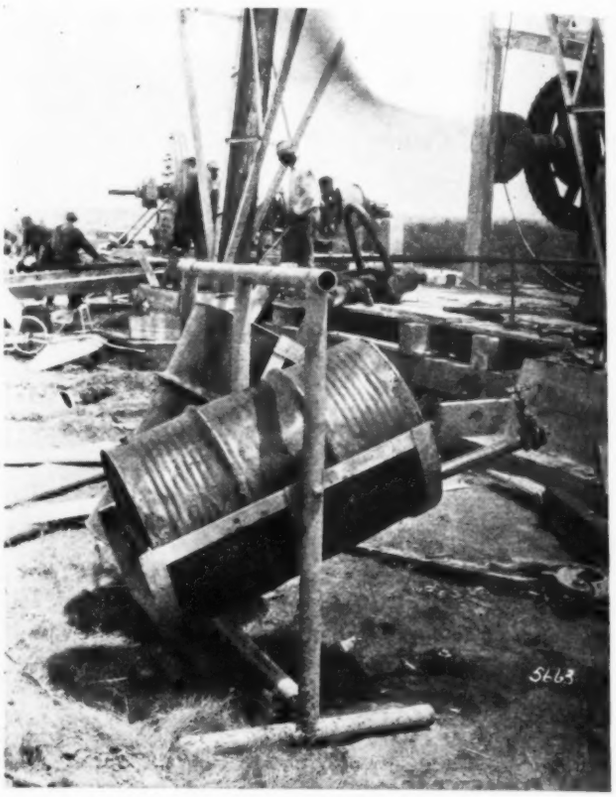
SIX natural gas companies have construction work under way in western and southern Oklahoma, according to reports from the Oklahoma Utilities Association. The State Fuel Supply Company is constructing gas distribution systems in Carnegie, Mountain View and Fort Cobb and has tentative plans to extend its lines to Gracemount, Binger, Geary, Lookeba, Bridgeport and Hinton.

Consolidated Gas Utilities Company is building a gas distribution system for Harmon and A. C. Fletcher has begun work on gas lines at Tishomingo and Madill. A gas line from Hooker to Beaver and Forgan has been completed by the Cimarron Utilities Company.

The Northwest Texas Gas Company is constructing a gas line connecting Atoka and Coalgate with the gas fields of northern Coal County, while the Community Natural Gas Company has completed lines in Snyder, Manitou and Mountain Park.

Easy Method of Handling Lubricating Oils on Drilling Wells

A SIMPLE but efficient method of handling lubricating oils around drilling wells is shown in the accompanying illustration. It is a rack made of two-inch pipe welded together and supports two cradles, into which the barrels of lubricating oil are placed. The old system of setting a barrel on its edge on the derrick walk and tilting it when



oil is required often resulted in considerable loss of lubricants. The above mentioned apparatus was made by the Noble-Olson Drilling Company and is now used with every one of their drilling rigs. It is simply and economically constructed and, according to the owners, has resulted in appreciable saving in their lubricating oil costs as well as furnishing a very easy method of handling this product.

Details of Tide Water's New Diesel Tankers

A CONTRACT was recently entered into between the Tide Water Associated Transport Corporation and the Sun Shipbuilding & Dry Dock Company for the construction of two deep draft sea-going tankers of approximately 13,500 deadweight tons each. The vessels will be built under special survey to the highest class of the American Bureau of Shipping. Each vessel will be practically 500 feet in length over all, with a beam of approximately 66 feet and drawing approximately 27 feet 6 inches in a loaded condition.

The general design provides for a two-deck, shelter deck type, with poop and forecastle built with a straight stem and semi-elliptical stern. The framing is the patented longitudinal bracketless system of construction. As usual in tankers, the machinery is aft, with the remainder of the hull proper divided by transverse and center line oil-tight bulkheads into nine main cargo oil tanks on each side of the center line. In addition to the main tanks, summer tanks, five on each side, are provided in the wing 'tween decks.

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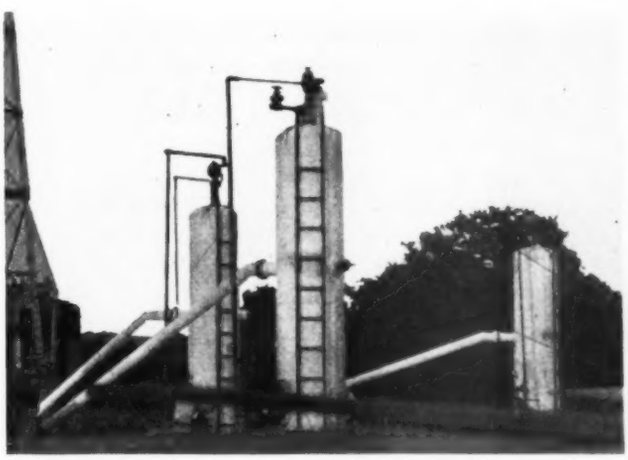

3—No. 4-A Nationals Handling the Largest Gas and Gasoline Well in the Oklahoma City Field.

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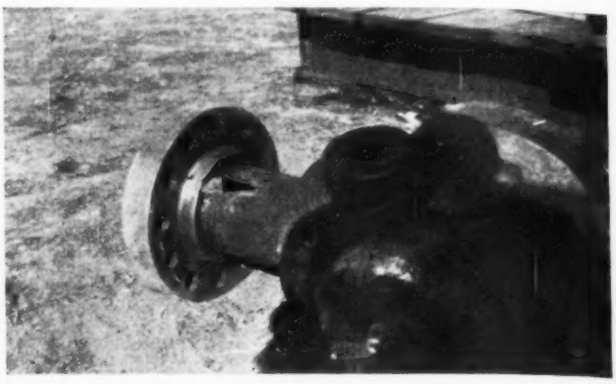
Big Pressure Cuts Thru Fitting

JUST how strong the pressures in the Oklahoma City field are may best be judged by looking at the above illustration. It shows a casing head which was cut completely through by the heavy flow of one of the largest wells



in the field. The sand cut occurred near the flange and is seen at the extreme left of the head.

There have been instances where steel flow nipples of the best material obtainable have been cut through in 45 minutes in this field.

Richland Parish Gas Well Did This

IN the Louisiana Gas fields they encounter some terrific pressure, especially in Richland Parish. Well cratering is very often experienced as a result of the heavy gas flows

encountered. The above photograph shows an ordinary rotary table, the under side of which was completely sand cut by an unusually large gas well.

Not an Accident at Wood River the First Half of 1929

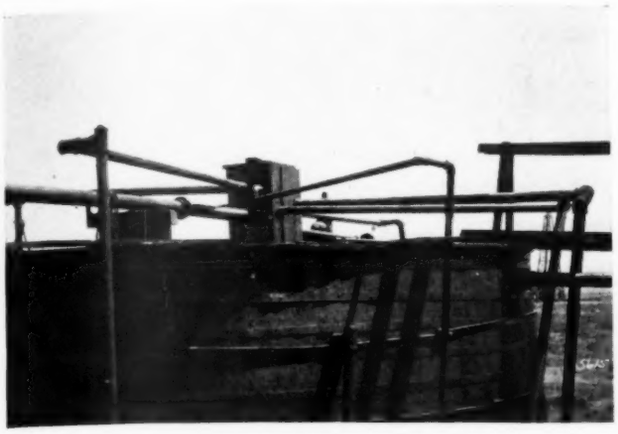
THE Wood River refinery of the Standard Oil Company (Indiana) has won the national safety contest sponsored by the national safety council among the larger refineries of this country.

Wood River won over 27 competitors by going through the first six months of 1929 without a lost-time accident.

The contest was launched the first day of January, 1929, by the petroleum section of the national safety council. Sixty-four refineries were entered from all parts of the United States. The 64 entrants were divided into class A and class B refineries. A class A refinery was a refinery that worked 100,000 man hours per month or more. This means that practically all entrants in class A would have to have 500 or more employes. Refineries having less than 500 employes or working less than 100,000 man hours per month fell in class B. There were 37 entrants in this class.

Look Box on Lease Tank

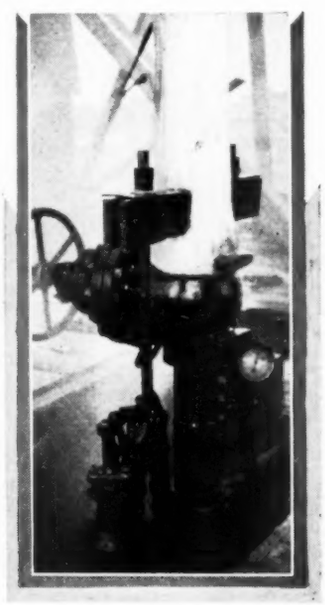
IN the above picture is shown the lead lines from a number of wells connected into a look box on top of the lease tank. These look boxes are in use by the Phillips Petroleum Company in the Peabody field, Kansas, and en-



able the pumper, with a minimum of trouble, to observe what wells are pumping and estimate how much each is making.

Hooking-Up Heavy Gas Well

THIS picture was taken the morning after the well illustrated was hooked up. It shows the usual manner of harnessing the big gas wells in the Oklahoma City field, and also shows the thick coating of ice which covers the pipe



and equipment. The pipe clamps are straight across the casing in the picture, but the pressure of the well was so heavy that in 24 hours the clamps were bent two inches out of line.

PARKERSBURG STEEL PITMANS are amply described in a folder issued by Parkersburg Rig & Reel Company. There are two types of Pitman, one recommended for pumping and the other recommended for drilling wells. The type recommended for drilling wells has a quick acting boomer which permits a rapid and easy removal from the wrist pin.

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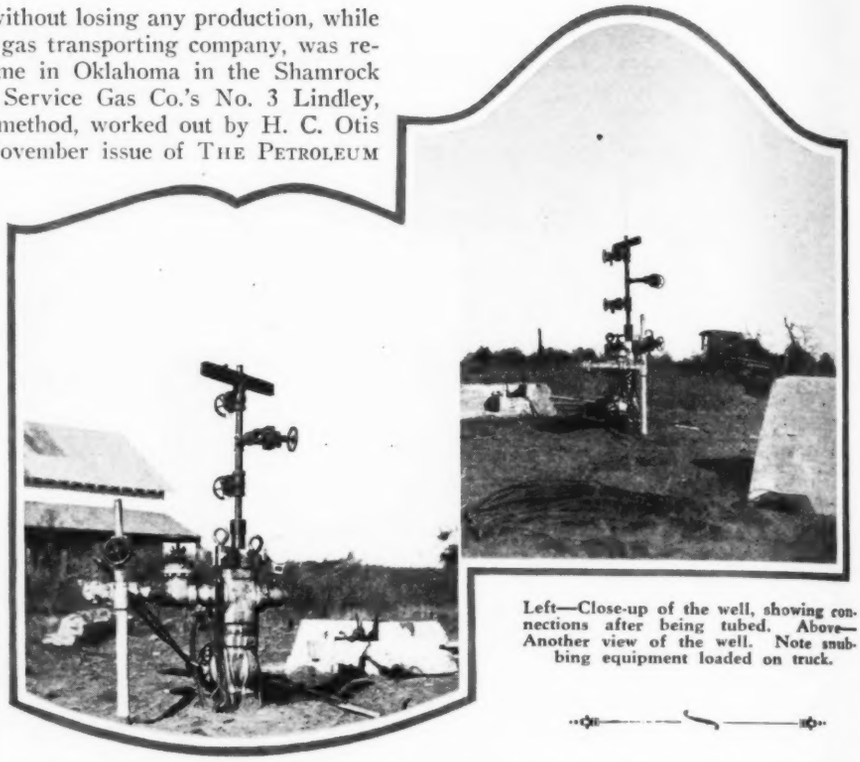
Tubing Gas Well Under Pressure

TUBING a gas well under pressure without losing any production, while the well was being pulled on by a gas transporting company, was recently accomplished for the first time in Oklahoma in the Shamrock field in Creek county. The well, Cities Service Gas Co.'s No. 3 Lindley, Section 30-15-8, was tubed by the Otis method, worked out by H. C. Otis of Shreveport, La., and described in the November issue of THE PETROLEUM ENGINEER.

No. 3 Lindley has an open flow capacity of 55,000,000 feet of gas with 710 pounds rock pressure, producing from a total depth of 3,275 feet. It had been planned to tube the well on a day when weather conditions would permit taking it off the line. Unfavorable weather upset the plan, but when the transporting company was assured it could be tubed under pressure while being produced, the tubing crew proceeded with its work.



Left—Close-up of the well, showing connections after being tubed. Above—Another view of the well. Note snubbing equipment loaded on truck.

Arrangements had been made to tube several wells in that territory and a crew taken from the Monroe, La., field was sent to Oklahoma. All of the equipment necessary for the work was transported on one truck especially equipped for that type of work. The same method used in tubing large volume high pressure gas wells in northeastern Louisiana was used to tube the wells in the Shamrock field. The same method of closing the bottom of the tubing to prevent gas from flowing through the tubing as that described in Mr. Otis' paper was used. The gas produced for the pipe line while the well was being snubbed was taken from a connection below the snubbing device.

It requires a day and a half to tear down and set up the snubbing equipment when the move to another location is only a short distance. Two full days are required to snub in the tubing and put on the connections. On the first well it required two full days to land the 3,200-foot string of tubing, but in tubing other wells in the same area less time was required. On the first well tubed, the crew proceeded with the work more slowly because the members were more or less feeling their way along in a new territory.

One trouble experienced by several wells in that territory is expected to be overcome by the running of tubing under pressure. That trouble is the tendency of wells to drill themselves deeper when being unloaded of water and, of course, the conservation features connected with tubing wells.

It is probable that tests will be made sometime in the near future in tubing deep producing oil wells under pressure. Heavier equipment than that now being used will likely be employed when the deep oil producers are tubed.

Left—The husky crew which tubed the well.
Above—J. M. Seward (left), and R. R. Brandenthaler, of the U. S. Bureau of Mines, Bartlesville, Okla., in the field to observe the running of the well under pressure.

Conoco Is Deep and Shallow Producer

THE Continental Oil Company is now the shallowest and deepest producer of oil in U. S. In the Pecos district they are pumping 15 barrels daily from a 15-foot producer, and from the University B-1, Santa Rita, Texas, they are pumping 2,800 barrels daily from a depth of 8,523 feet.

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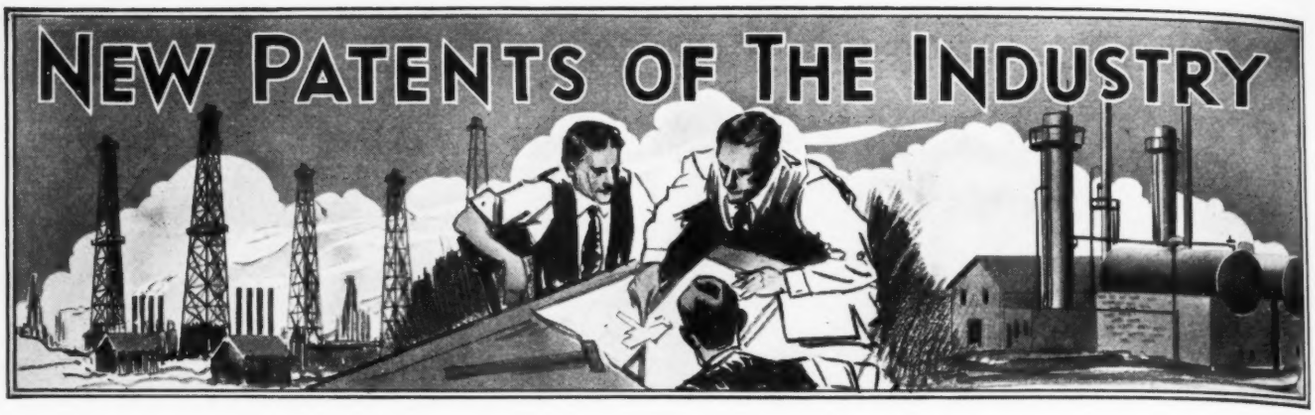
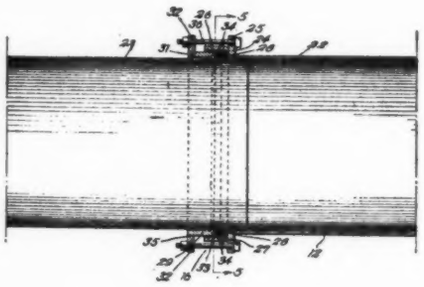
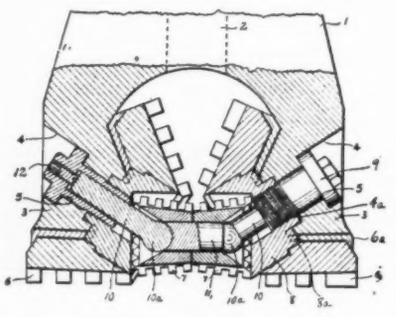


1,731,761. GAS-MAIN EXPANSION JOINT. HENRY E. BULMAHN, Fort Wayne, Ind., assignor to The Western Gas Construction Company, Fort Wayne, Ind., a Corporation of Indiana. Filed Feb. 10, 1927. Serial No. 167,289. 2 Claims. (Cl. 285—135.)

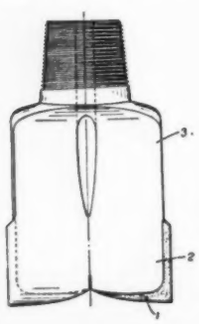


1. An expansion joint for the adjoining ends of a pair of metallic gas-conduits communicably connected with each other at their adjoining ends for relative movement comprising, in combination: a stuffing box consisting of a single fixed annular metallic tying-ring welded circumferentially to the end of one of said conduits that adjoins the other conduit, and a single separate annular metallic chamber-forming ring disposed at a spaced distance from the inner annular surface of and welded thereto the side of said fixed tying-ring and extending therefrom directly over and spaced circumferentially from the other conduit to form a packing chamber therebetween; a gland consisting of a single free annular metallic tying-ring disposed circumferentially of and freely encircling the other conduit for movement relative to both conduits and the packing chamber, and a single separate annual metallic compression-ring disposed against the inner annual surface of and welded thereto said fee tying-ring and extending therefrom directly between the said chamber-forming ring of the stuffing box and the circumference of the other conduit so as to compress packing within the chamber formed therebetween; and means for drawing the gland tying-ring towards and tying it to the stuffing box tying-ring to effect compression by means of the compression-ring of packing within the packing chamber formed by the packing chamber ring.

1,734,760. ROLLER BIT. CLINTON H. M. BULL, Houston, Tex., assignor to Reed Roller Bit Company, Houston, Tex., a Corporation of Texas. Filed Dec. 17, 1927. Serial No. 240,670. 8 Claims. (Cl. 255—71.)

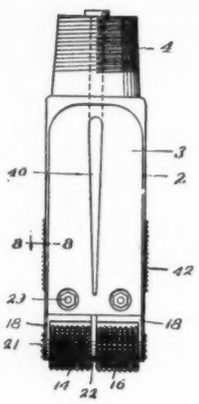


1. In a rotary boring drill, a pair of cutter spindle supporting pins having balls on the ends thereof, a cutter spindle, and a roller cutter on said spindle, said spindle having pockets in the ends thereof shaped to revolubly receive said balls.



1,733,241. METHOD OF PRODUCING A HARD SURFACE ON TOOLS AND THE LIKE. FLOYD L. SCOTT, Houston, Tex., assignor to Hughes Tool Company, Houston, Tex., a Corporation of Texas. Filed Aug. 6, 1928. Serial No. 297,877. 4 Claims. (Cl. 76—108.)

1. The method of producing a hard surface on iron and steel cutters comprising placing small particles of tungsten carbide upon the edge of said cutter, and partially melting said carbide and the body of said cutter and thus securing said carbide to said cutter by an alloy of tungsten carbide and iron.

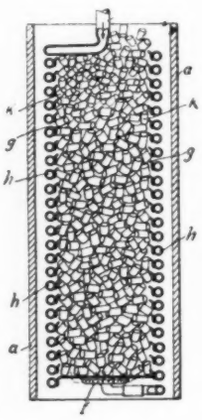


1,733,336. CONVERTIBLE DRILLING TOOL. JOHN B. DE COSTA, Kansas City, Mo. Filed Mar. 26, 1928. Serial No. 264,661. 1 Claim. (Cl. 255—71.)

A device of the character described consisting of a shank having a groove extending entirely across its under side, a central bracket having a tongue at its upper end adapted to enter and be positioned midway between the ends of the groove, bearings projecting in opposite directions from the lower end of said bracket, a pair of side brackets having tongues at their upper ends for entering said groove and abutting the opposite sides of the tongue on the central bracket, bearings on the lower ends of said side brackets adapted to abut the adjacent ends of the bearings on the central bracket, means for removably securing said brackets in place, and a pair of rotary cutters journaled upon said bearings.

1,732,791. WELL CEMENTING. ERD V. CROWELL, Los Angeles, Calif. Filed July 7, 1926. Serial No. 121,040. 4 Claims. (Cl. 166—1.)

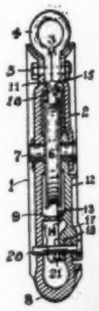
1. Well cementing means comprising casing adapted for reception in a well with its exterior surface in close proximity to the wall of the well and its interior surface defining a uniform unobstructed bore through the casing, a port opening through the side wall of the casing, the exterior surface of the casing having a depression therein at the port, a radially outwardly opening valve mounted in the depression and normally closing the port, and an abutment seated in the depression so as not to extend outwardly beyond the exterior surface of the casing, said abutment overlying the valve in normal spaced relation therefrom so as to permit limited opening movement of the valve, and the exterior surface of the casing having a laterally extending groove communicating with the depression.



1,732,664. APPARATUS FOR CRACKING OILS. SIGBERT SEELIG, Berlin, Germany. Filed Dec. 29, 1926. Serial No. 157,828, and in Germany Mar. 25, 1926. 3 Claims. (Cl. 196—70.)

1. In an apparatus for cracking oils and the like, a reaction vessel adapted to be externally heated and to contain a charge of molten metal, a continuous spiral tube annularly spaced from the inner walls of said chamber and disposed within said chamber in a position adjacent said walls, said tube being adapted to contain a fluid circulating therethrough to retard the flow of heat from said walls to the interior of the vessel, and means to conduct oil to be treated into said vessel.

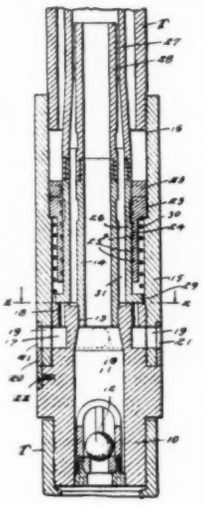
1,733,640. TACKLE BLOCK. DALLAS E. WRIGHT, Toledo, Ohio, assignor to The National Supply Company, Toledo, Ohio, a Corporation of Ohio. Filed May 17, 1928. Serial No. 278,584. 5 Claims. (Cl. 254—193.)



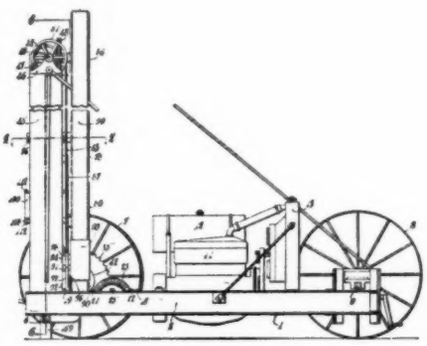
1. In a tackle block for a hoist line, a sheave and a casing enclosing the same and having a peripheral slot and comprising two members, one being rotatable and having provision for threading a hoist line between the sheave and the unslotted portion of the periphery of the casing.

1,723,993. OIL-WELL PUMP. LEE J. BLACK, Beaumont, Tex. Filed Apr. 17, 1928. Serial No. 270,744. 8 Claims. (Cl. 103—233.)

1. A nozzle for oil well pumps comprising a body having a bore, a tube threaded in the upper end of the bore, a nozzle element surrounding the tube, ports for admitting air between the nozzle element and the tube, the lower end of the nozzle element comprising a valve for sealing said ports, and a spring for seating said valve.



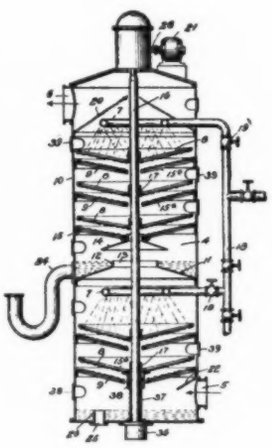
1,731,471. DRILLING MECHANISM. HENRY H. MERCER, Claremont, N. H., assignor to Sullivan Machinery Company, a Corporation of Massachusetts. Filed May 25, 1921. Serial No. 472,546. 38 Claims. (Cl. 255—37.)

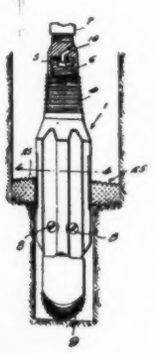


1. In a drilling mechanism, a double acting pump comprising relatively movable elements, means for reciprocating one of said elements, a hollow drill steel connected to and movable with the other of said elements and actuated by said means through said pump, and means for conducting pressure fluid generated by said pump to said hollow steel.

1,732,086. GAS SCRUBBER. JOHN P. FLIPPEN, Pittsburgh, Pa. Filed Jan. 6, 1926. Serial No. 79,544. 5 Claims. (Cl. 261—89.)

1. In combination in a gas scrubber, a gas washing chamber having a gas inlet port and a gas outlet port formed therein, means for dividing the chamber into two communicating compartments, co-operating stationary and rotary grids mounted in each compartment in the path of gas travel therethrough, means for introducing a spray of separate liquids in each compartment in the path of gas travel passing therethrough, and means in each compartment for collecting and discharging liquid from said spray.



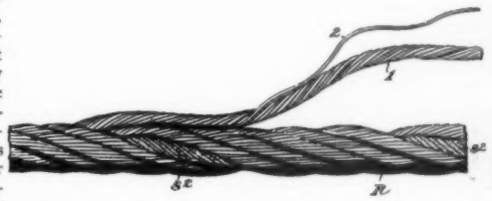


1,733,311. DRILL BIT. JAMES S. MCNEILL, Wewoka, Okla., assignor of one-half to Phillip H. Lively, Wewoka, Okla. Filed Oct. 24, 1928. Serial No. 314,694. 3 Claims. (Cl. 125—73.)

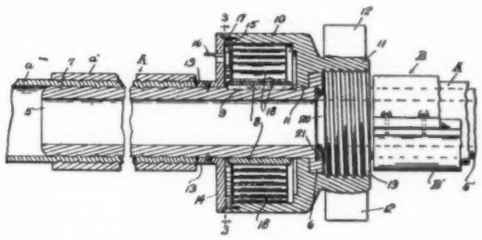
1. In a drill bit, a sectional body, a cutter carried by the lower end thereof, a block secured between the sections of the body and formed with a bore, a spindle extending through the bore, the outer end of the spindle projecting beyond the side of the body for disposition at right angles thereto, and a cutter unit rotatably mounted on the outer end of the spindle.

1,732,640. WIRE ROPE AND PROCESS OF MAKING SAME. EDWARD A. CONNER, Stratford, Conn., assignor, by mesne assignments, to American Cable Company, Inc., a Corporation of Delaware. Filed Apr. 29, 1926. Serial No. 105,352. 4 Claims. (Cl. 117—59.)

1. In the process of making inert-lay wire strand, adapted to constitute a component of an inert-lay wire rope, the steps which comprise laying a plurality of wires together under tension as components forming an expansile strand and subsequently subjecting said expansile strand to a force adapted to impart a helical formation to the strand as a unitary structure and thereby to convert said individual wires severally from said expansive formation to a substantially stress free inert-lay conformation, prior to laying the strand into the rope.

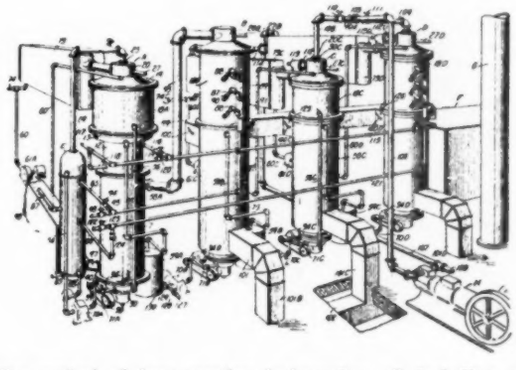


1,731,320. AUTOMATIC PIPE COUPLING. MYRTLE B. RATCLIFFE, Winston-Salem, N. C. Filed Feb. 8, 1928. Serial No. 252,790. 2 Claims. (Cl. 285—122.)



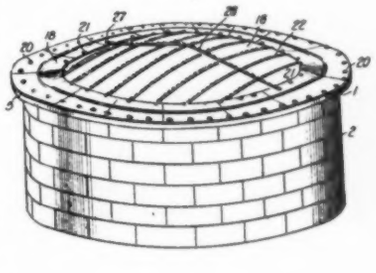
2. In a pipe coupling of the class described, a stationary coupling member, a rotary coupling member, complemental locking structure between the members when one is rotated with respect to the other, normally wound spring means associated with the rotary member, means for locking said spring means in wound condition, and means whereby said spring means may be released for causing the rapid rotation of the said member bringing about the locking of said complemental locking structure.

1,732,805. METHOD OF HEAT TREATING HYDROCARBON OIL. EDWARD C. D'YARMETT, Kansas City, Mo., assignor to The Fractionator Company, Kansas City, Mo., a Corporation of Missouri. Filed Nov. 3, 1928. Serial No. 316,947. 14 Claims. (Cl. 196—128.)



1. The method of heat treating hydrocarbon oil including admitting a stream of oil to a confining vessel, circular in cross-section and of extending surface area, rotating the oil at a speed sufficient to maintain the oil in the form of a continuous film on the inner surface of the vessel, heating the vessel, transferring heat from the vessel to the film of oil, and collecting vapors evolved from the oil within the space surrounded by said film.

1,732,779. TANK. JAY A. STOUGH, Tulsa, Okla., assignor, by mesne assignments, to The Philip Carey Manufacturing Company, a Corporation of Ohio. Filed Jan. 9, 1928. Serial No. 245,602. 6 Claims. (Cl. 220—88.)



1. In a tank having a metallic side wall and a roof including elements non-conductive to electricity, a conducting strip comprising overlapping sections each having a plurality of resilient bosses, the strip extending across the roof and having conductive relation with said side wall, and means bearing on said resilient bosses engaging said elements and attaching the strip to the roof.

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